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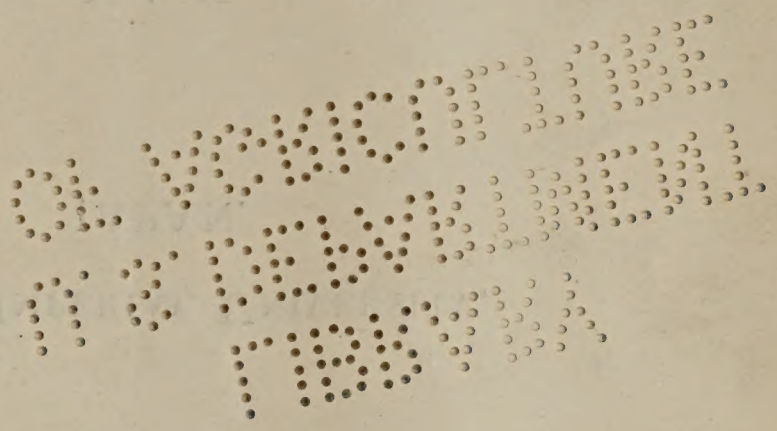

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The Energy of the Living Protoplasm.

BY *Dr. Oscar Loew.*

Professor of Agricultural Chemistry.

CHAPTER I.

FORMER VIEWS ON THE CAUSE OF THE VITAL PHENOMENA.

The change from life to death is so striking, that it has been from the oldest times up to the present day considered as a mystery, as an inconceivable supernatural process. Not less striking than the death of a larger animal or plant is the death-moment of the lowest forms of animal or vegetable life, watched under the microscope. The motions of infusoria cease, the diatoms stop, the spirogyracells show contraction of their green spirals, their cytoplasm loses its shape, their nucleus leaves its normal position. All energy, mechanical or chemical, is gone!—

Living organisms produce *heat*, the nervous system *electricity*, certain fishes even powerful electrical phenomena, a number of animals and fungi emanate *light* and all the animals as well as some forms of lower vegetable organisms are capable of *locomotion*. And what a great amount of *chemical* energy is actively engaged in producing organic matter in plants, on the one hand, and in decomposing and oxydising it in animals on the other! All these phenomena stop at the moment of death. But what is the cause of the disappearance of the forms of energy? It is of no avail to answer: "Respiration produces heat which can be converted into other forms of energy;" here the fundamental question is: *What has produced the respiration process? Why* does this process stop at once at the moment of death?—

Before we enter upon the discussion and scientific treatment of this question let us glance at the opinions of ancient philosophers and modern physiologists in regard to the cause of the vital functions.

Anaxagoras defined an animal as an automatic machine, but he left undecided what cause moved the machinery. *Socrates* ridiculed this idea even on his death-bed.[1] According to *Aristotle* the animal motions and animal heat are intimately connected; the heat is produced by the food. The heart is the centre of motion and sensation, has a life of its own, and is the hottest part of the body.[2] *Plato* considered the red color of the blood as an effect of the life-fire, and the blood itself as the bearer of the vital force, as the seat of the soul.[3] The *Pythagoreans* defined animal life as the result of the entrance of the "life-spirit" into the body[4] by the respiration-process, and declared the brain to be the seat of sensation.—As the scientific development ceased in Europe for a very long time, we do not find any discussions upon this subject up to *Descartes*, who in the year 1637 expressed his conviction that all the forces of nature consist in certain motions of the molecules; the animals were in his opinion caloric automatic machines, in which the motions of the blood and of the organs are the effects of chemical heat-producing processes. The finest parts of the blood are a kind of nervous ether that ascends from the heart to the brain.[5] *Baco* and *Descartes* were the first, who considered heat as a mode of motion, and *Descartes* extended his views also to light, electricity, and magnetism.

With the observation of *Galvani* in the year 1780 of the convulsions of a frog's leg brought in contract with two metals, the view of *Galvani* found numerous followers, and men like *Humboldt* were among the admirers of the new vital theory. However *Volta's* experiments an contact-electricity soon eclipsed the results of *Galvani*, and when the latter succeeded in the year 1793 in adducing irrefutable proof of the presence of an electrical current in the animal: electrical contraction *without* metals, it did not find grace with the scientific public; the doubts and distrusts created by *Volta* were mightier than the

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1) *Plato*, Phaedon 97, 98.

2) *Aristotle* (Editio Bekkeri) de part. anim. II, 1; III. IV, 4, 7; V. 2.—Hist. anim. I. XVII.—De respiratione VI.

3) *Plato*, Tim. 493 etc.

4) *Democrit*, in: *Aristotle*, de respiratione IV.

5) *René Descartes* works, edited by *H. Kirchmann*, II, 27.

language of the new experiments; *Galvani* did not receive any satisfaction, he died without having found any recognition. And when *Du Bois Reymond* proved in the year 1843 the correctness of *Galvani's* views of the presence of electrical currents in animals, nevertheless no voice was raised in favour of the theory that electricity is the "*primum movens*" of all the vital phenomena. And indeed the electrical phenomena observed are just like the heat secondary actions, but not the first cause of life.

Since the middle of last century another view has gained much foothold—, a view that was even defended by *Liebig*—, the theory that organisms are ruled by quite a specific force, different from any other, inscrutable to men, and supernatural: this force was called *vital force*. *Justus Liebig* said: "the cause of vital force is not chemical force, not electricity, not magnetism; it is a force that possesses the most general qualities of all causes of motion, of variation of form and qualities of matter, and a *specific* force," because it produces effects like no other force." "The laws of life and every thing disturbing, promoting, or varying them can doubtless be investigated, but without ever knowing what life really is." Even in the third edition of this work[1], published 1846, we find upon the first page: "in the animal egg, in the plant-seed is recognizable a remarkable activity, a cause of increase in substance, a compensation of loss, a force in the state of rest..... this force we call *vital force*." From page 225 the following characteristic passage may be quoted: "another fundamental error entertained by physiologists is, that physical or chemical forces alone or in combination with anatomy could suffice to explain the vital phenomena."

This reactionary movement of *Liebig* was principally due to the opposition to the great and fervent hopes created by the first synthesis of an organic compound, namely that of urea by *Woehler* in the year 1828. Previous to this year it was often asserted that organic substances could only be formed by "vital

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1) Die organ. Chem. in ihrer Anwendung auf Physiol. und Pathol., Braunschweig 1842 p. 7 and p. 237. These few quotations will clearly show how erroneous the opinion is, that *Liebig* was the first, who combated the hypothesis of the supernatural vital force, an opinion, which we find in some german textbooks of physiological chemistry. See also Chem. Briefe of 1858. Chapt. 23.

force," a view that was adopted by *Berzelius* in 1827 in Vol. III p. 1. of his textbook of chemistry. But even in the year 1847 this prominent chemist declared that life is something mysterious and inscrutable; "once connected with matter it produces development and growth, but how this proceeds is an insoluble mystery [1]. Similar declarations were made by *Treviranus*, who believed that the vital principle passes off into the air with the death of an organism [2]. The view that "life was not in any way related to the physical forces and had nothing in common with any material forces, powers, or properties," was even defended quite recently by some learned professors of the *Victoria Institute*, London [3]. "Different views however were entertained nearly a hundred years ago by the German physiologist *Reil*,[4]: "the socalled vital force has fooled us long enough, and has led us into sterile deserts. Matter itself and not a specific new force is the cause of vital phenomena." Such was essentially also the conviction of *Oken* and of *De Candolle*, while *Mulder* [5] declared: "the vital force is a *specific* force connected with the 4 elements: carbon, hydrogen, nitrogen and oxygen."—*Erlenmeyer*, well known for his numerous investigations in the domain of theoretical organic chemistry declared [6]: "all our knowledge of chemistry and physics has been set in motion to solve the mystery of life, and we have made a great step forward; but if a physiologist like *C. Ludwig* identifies the progress of physiology with the progress of chemistry, then the chemists must feel anew instigated to devote themselves to physiological problems." "The vitalistic school had more power in former times, chemistry and physics having been too imperfectly developed." To similar opinions inclined the physiologist *Lehmann* (1853): "if many vital phenomena are inexplicable up to the present day, we still do not feel the necessity of nominating such a governor as vital force.[7]" Quite differently expressed himself another physiologist, *Gorup-Besanez* (1874): "All the physical and chemical laws known to

1) Lehrbuch der Chemie, 5th Edition, Vol. 4, p. 5.
2) Physiologie der Gewächse 1835. Vol. I, p. 12.
3) Compare "*Science*" of March 1893.
4) *Reil's* Archiv III, 424 (1798).
5) Versuch einer allg. physiol. Chem. p. 92 (1843).
6) Zeitschrift f. Chem. 1859.
7) Lehrbuch d. physiol. Chem. II, Ed. Vol. III, p. 154.

us at the present day are not sufficient to explain the formation of a plantcell, the process of generation or the conduction of the sense-impressions to the brain.[1] "

Among those who most emphatically denied the necessity for the hypothesis of a special supernatural force were: *Schleiden*, *Matteucci*, *Moleschott*, *Huxley*, *Haeckel*, *R. Mayer*, *F. Hüppe*, *Heidenhain and Halliburton*. *Schleiden*[2] uttered the following philippica: "Only ignorance and indolence of spirit are the defenders of the vital force at the present state of development of the natural sciences, of a force that can accomplish everything and explain everything, and of which nobody can tell, how it acts nor what laws it obeys. The savage, who takes a locomotive for a wild animal, is not more ignorant, than the natural philosopher who talkes about vital force in organisms."

Matteucci: "to explain everything by vital force, and yet not to know the laws of this supposed force, explains nothing; it is even worse than nothing, it prevents the mind from searching after the truth.[3] "

Moleschott: "Life is not the result of a specific force, it is a certain state of matter caused by peculiar motions produced by heat and light, water and air, electricity and mechanical convulsions.[4] "

Th. Huxley[5]: "To speak in what is not altogether a metaphor, the atoms, which enter the body are for the most part piled up in large heaps and tumble down into small heaps before they leave it. The force, which they set free in thus tumbling down, is the active power of the organism." *Huxley* forgets, however, to mention the *cause* of the "tumbling down." *Haeckel* takes the question still easier, he finds the formation of a cell as simple as that of a crystal, and assumes the existence of sensation and motion in every atom. This "soul" is modified and perfected by the development of the organisms.[6]

Very naturally *Robert Mayer* did not believe in a mysterious

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1) Lehrbuch der organ. Chem. 3rd Ed. p. 6.

2) Grundzüge der wissenschaftl. Botanik I, p. 60 (1844)

3) Lezioni sui fenomeni fisico-chimici dei corpi viventi. 2d Ed. p. 10. (1846)

4) Kraft and Stoff, 3rd Ed. p, 256 (1856)

5) Lessons on elementary physiology, lesson VII (1870).

6) Generelle Morphologie der Organismen, Vol. I p. 143 and 148. See also: Tageblatt der Naturforscherversammlung zu München 1877 p. 22.

force in the cells, he declared vital activity to be the result of chemical processess whereby energy is liberated. What *caused* those chemical processes he could not tell. *Heidenhain* takes it for granted, that all the vital actions are nothing but peculiar connections of physical and chemical forces exerted from the living cells,[1] and similar views were entertained by the well known Chemical Physiologist of Great Britain: *Halliburton*,[2] and by the physiologist *F. Hüppe*[3] in Prague. It will be forever remembered how *Du Bois-Reymond* undertook to draw boundaries of knowledge in pronouncing his "*ignorabimus*" in regard to the more complicated vital actions, at the meeting of the *German Association for the advancement of science*, in Leipzig, 1872. The learned professor however expressed 30 years earlier a different view: "Those who preach the erroneous doctrine of the vital force, under whatever form and in whatever disguise it may be, such heads have—they may believe it—never reached the boundaries of thinking.[4]"

The "ignorabimus" of *Reymond* would certainly not have found favor with *A. Humboldt*, who in the year 1797 stigmatised all exertions to draw boundaries of knowledge as paralysing scientific activity.[5] Of the German physiologists it was especially *Pflüger* who protested against such a thing by declaring: "Whoever in our time undertakes to draw boundaries for the development of science thinks his own brain-work worth at least just as much as that of numberless generations to come.[6]" We conclude with citing the view of the great *French* physiologist *Claude Bernard*: "Pour comprendre les fonctions de l'organisme il faut connaître celle de la cellule. La raison des phénomènes vitaux est dans cette fonction élémentaire: le moyen de les maitriser, de les modifier, d'agir sur eux, consiste à agir sur l'activité cellulaire.[7]"

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1) Handbuch der Physiologie V p. 11. (1880).
2) Chemical Physiology, Chapt. 14.
3) On the cause of fermentations etc. Berlin 1893. p. 14.
4) Preface to the first edition of his work on animal electricity; p 39.
5) Versuche über de gereizte Nerven-und Muskelfaser, Vol. II p. 77.
6) Die allgemeinen Lebenserscheinungen, Bonn 1889, p. 11.
7) Lecons sur les phénomènes de la vie communs aux animaux et aux végétaux. p. 458 (1878).

CHAPTER II.

Modern Steps of Progress.

The attempts to penetrate the mysteries of the morphological and chemical conditions of living cells are of comparatively recent date. After *R. Brown* for the first time described the cellular nucleus in the year 1833, and a few years later were published the investigations of *Schwann* and of *Schleiden* on the cellular structure of the organisms, when attention was drawn by *Dujardin* to the apparent structureless, semifluid contractile substance of some of the lowest kinds of animal forms, called by him sarcode. Soon afterwards *Mohl* observed (1846) the presence of a similar substance in plant cells, which he called *protoplasm*. *Schulze* demonstrated later the chemical identity and showed that this substance lies at the base of all the phenomena of animal and vegetable life. Every vital act depends upon the some mode or property of protoplasm, which is of albuminous character, and is the tangible reality, the chemical foundation of life. That was the first important generalisation in the domain of biological science.—Numerous observations followed: the circulation in the vegetable protoplasm and its dependence upon the access of air, the division of the nucleus and, quite recently, the central corpuscles were discovered, the protoplasmatic nature of the chlorophyllcorpuscles was demonstrated, the leukoplasts were described. Important qualities of the cytoplasm became known and the different functions of the outer and inner layer (cortical layer and tonoplast) were noted.

Attempts were even made to decipher the finer structure of the cytoplasm and nucleus, and a reticular structure was distinguished from a hyaline and apparently uniform interfilar protoplasm. It was further shown, that not a single chemical process of importance can take place without the participation of protoplasm; even each single starch-granule has its own protoplasmatic manufacturer. Protoplasm is artist and tool simultaneously, it cannot be a formless albuminous slime, it must possess specific organisations according to the different functions it performs. In the molecular condition of protoplasm

there is probably as much complexity as in the disposition of the organs of the higher animals. The variations of protoplasm are astonishing; the adaptivness to different functions unsurpassed by any of the higher developed organisms. How different must be the molecular arrangement in the celles of the bile-producing liver from that of the cells of saliva-and again of the cells of milk-producing glands! How different a machine must exist in the cells of the resin-producing glands of the conifers from that of the sugar-secreting cells of the nectaries. What a wide difference again must exist between the organisation of a fungus-spore and a pollen-cell! Only individualised, specifically organised, till to the finest detail jointed and differentiated structures can be the sources of the different actions connected with life! *Hanstein* expressed this logical conclusion in the following words: "Even the most simple *Protococcus* or *Monad*-cell is certainly of a complicated organisation, even if so small that the best microscopes do not reveal a differentiation of the cytoplasm; there is no vital action without a vital structure.[1]"

But nothing would be gained from the differentiation of the protoplasmatic machines, if there were no motive power. What kindles then the fire, that produces the necessary steam? That "primum movens" must be united with the machine, most intimately connected with it, and is absolutely necessary for bringing on the most wonderful differentiations in form and functions, which arise from a single original egg-cell, when developing itself to an animal with the complicated system of nerve,-muscles and gland-cells, with the different cellular forms in epidermis and in bones. What a great variety of cellular forms are found in a tree! How many cells must sacrifice their individual existence during the development of an organism for the formation of tubular systems and aquaeducts!

How in view of these most complicated phenomena the older opinion can still be defended by some physiologists that the protoplasm is a *varying mixture of different substances*, is a "mixtum compositum", remains incomprehensible to a logical mind. *Reinke* found for instance in the plasmodium of *Aethalium septicum* (a fungus belonging to the mixomycetes), 27 percent of carbonate

1) Das Protplasma, p. 308 ff. (1880).

of lime, and concludes, that this belongs to the molecular system of this organism and contributes to its vitality! But if all the substances found in protoplasm participated in the first cause of life, then all excretionary substances that remain previous to their expulsion for a certain time in the protoplasm, further the sugar formed from starch and converted the next moment into cellulose, the hydrocarbons, aldehydes and esters produced to attract insects for fecundation of the flowers, the wax secreted to form a film upon the epidermis of leaves, the urea and uric acid produced in animals from proteids: all these substances would be parts of protoplasm and would participate in the cause of vital functions. All these combinations are *formed* in the protoplasm of different cells and must exist there even if only for a short time. This old view of declaring everything found in protoplasm to be an essential part of the protoplasm, and attributing to it even vital actions leads simply to absurdities!—

Hanstein defined protoplasm "as a semiliquid substance *consisting of proteids*, insoluble in water, generally of neutral reaction, transparent and refracting the light a little more than water." This definition however is not perfect; we miss the chemical side of the question, above all the *distinction between living and dead protoplasm*. The first, who treated this problem scientifically, was *E. Pflüger*[1] in the year 1875. He started from the chemical fact that the living cells take up oxygen, while the dead do not. From this fundamental difference the conclusion is justified, that the albuminous substance of the *living protoplasm* has another chemical character than that of the *dead protoplasm*. In other words: the living protoplasm is exceedingly liable to chemical change, and if that change takes place, death results. *Pflüger* pointed out also, that the decomposition of albuminous matter in the living animal organism yields other products that the decompositions artificially accomplished in the laboratory and concluded, that the nitrogen of the "living albumen" is linked in a different manner to other atoms.[2] He supposed that the cyanogen-group is this form,

1) Pflüg. Arch. Vol. 10.

2) This conclusion is however not justified; the same albuminous matter can yield under different conditions very different products. The albumen, which is oxydised in the living body is certainly for the greater part circulating dead albumen and not living protoplasm. The latter brings on the oxydation of the former.

and that this form is changed by the fixation of water when the cell dies:

$$. CN + H_2O = . CO\ NH_2$$

But it may be here objected, that such changes do not take place spontaneously or easily.[1)]

The conclusion however that a *chemical* difference exists between living and dead protoplasm is plain logic.—If the dead matter of our food is converted into the living matter of our nerves, muscles and glands, a considerable chemical change must take place and just in the opposite direction to that connected with the loss of life. *Pflüger* (l. c.) expressed his conviction in the following words: "An albumen-molecule, which in the brain concurs in the production of thought, which in the spinal column mediates sensation, which in the muscles performs mechanical work or in the glands starts chemical activity, is doubtless derived from the same dead albumen of the blood, but it is changed in chemical character as soon as it enters the living cell.[2)] From the moment it forms a part of the living protoplasm, it commences to respire, to live. Only the *cells* have the property of life; such albumen, which has not become protoplasm, is dead albumen, even in the living body."

The deductions of *Pflüger* did not attract the attention they deserved, they were even ignored by most physiologists. The cause may be found on the one hand in want of knowledge of the progress of modern chemistry, and on the other in the reactionary situation created by the echo of the "ignorabimus" of 1872, still vibrating through the sultry atmosphere. Foremost among those who assented, stood of *M. Nencki*, who declared[3)]: "I have repeatedly expressed my opinion, that investigation into the albuminous bodies must take a new direction, if we want to

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1) *Pflüger* had here evidently the comparison with *nitriles* in view. Certain other cyanogen-combinations, as cyanic acid, cyanamid, which undergo spontaneous changes, of course can not serve here for comparison or explanation.—

2) This production of living matter from dead was declared by *Pflüger* to be one of the greatest enigmas of nature (Die allgemeinen Lebenserscheinungen, Bonn, 1889). The supposition of *Pflüger* that *Liebig* entertained the belief in a *chemical* difference between albuminous matter in living and dead cells, is an error. Nowhere in *Liebig's* writings can a decisive opinion be found.

3) Arch. f. exper. Pathol. und Pharmacol. Vol. 20, p. 343. and Journ. f. prakt. Chem. Vol. 26.

undertake with success the closer investigation of those actions we call "life;" the proteids of the living cells must have another chemical constitution than that of the dead cells." And [1]: "It is of essential significance, that albuminous substances isolated at very low temperatures from living animals, are of a very changeable character, as for instance the blood plasm, the oxyhaemoglobin, the myosin." "The most important function, nay even the most characteristic feature of life itself is the formation of labil albumen molecules." [2]

O. Rosenbach, discussing the vital phenomena [3] concludes: "Death is the suspension of the labil equilibrium of atoms in the living matter." Among the plant-physiologists was *Detmer* the only one, who defended the new ideas; but his modifications will hardly find approval. He assumes, that the atoms of the "living albumen molecules" are in such a lively motion, that a continuous *dissociation* of the albumen-molecules takes place, forming thereby on the one hand non-nitrogenous substances as glucose and on the other amides. By this *dissociation* respiration is induced, and the other vital phenomena are made possible.[4] Such a hypothesis however is incompatible with the great sensibility of the protoplasm towards every disturbing influence. The continuous *regeneration* supposed by *Detmer* would be simply an impossibility, as death would have resulted from the dissociation. The view of *Detmer* would well nigh answer for a description of a protoplasm committing suicide.

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1) Ber. d. Deutschen Chem. Ges. Vol. 18, p. 385.

2) Pflügers Arch. Vol. 31, p. 336.

3) Aufgaben der Therapie, Chapt. 14. (1891).

4) Vergleichende Physiologie des Keimungsprocesses, Jena 1880.—Ber. d. Deutschen Botan. Ges. 1893.

CHAPTER III.

Living Protoplasm and Chemical Lability.

The view that at the moment of death a *chemical* change of the living matter takes place, finds support not only in the loss of affinity to the molecular oxygen of the air, but also in the different behaviour towards certain coloring matters as anilin colors, by which no living protoplasm, but only *dead*, can be *stained*, the latter even if the coloring substance be very diluted. Some phenomena accompanying the death of an animal are also in this relation very noticeable, siz. the *rise of temperature* observed, when soon after the death of the nervous system the muscular tissue is also succumbing, not being nourrished any longer by currents of oxygenated blood.

This socalled post mortal *rise of temperature* known long ago and often incorrectly interpreted is really the *mortal* rise connected with the proceeding death of the muscular tissue. Heat is produced by chemical changes; chemical energy being easily transformed into heat.

Intimately connected with the death of the muscles is the formation, resp. the increase of an *acid* reaction and of *rigidness*.

All these facts can only be explained if the proteids of the living cells undergo a chemical change; and we may therefore distinguish them as *active* proteids from the *passive* proteids of the dead protoplasm. The name "*living* albumen," used sometimes, cannot signify anything else but living protoplasm, as life is always the result of an organisation, of functions of protoplasmatic machines, and albumen itself *without* organisation cannot be called "living," even if a high lability should lead to much chemical energy. All the steam of a locomotive would not pull the train, if the machine were not properly constructed. The name "living albumen" should be discarded altogether, as it might lead to erroneous conceptions. The name *active* albumen, on the other hand, expresses merely a chemical quality, a distinction of ordinary albuminous matter. Still preferable is the name "active proteids," when the whole living matter of a cell comes into consideration, because also active

nucleins and perhaps related proteids participate in the composition of the organoids of the cell. *The active proteids become living protoplasm by the process of organisation.*

What kind of chemical character must then be ascribed to the active proteids? We can answer this question but in one and that at being decided sense: They are *exceedingly labil compounds* that can be easily converted into relatively stable ones. A great lability is the indispensable and necessary foundation for the production of the various actions of the living protoplasm, for the mode of motions that move the life-machinery. There is a *source of motion* in the *labil* position of atoms in molecules, a source that has hitherto not been taken into consideration either by chemists, or by physicists.

The opinion that at a given temperature the motions of all atoms in a compound are equal must be refuted as erroneous. Labil atoms have a greater energy of motion than the stable ones of the same substance.[1] We know, that the atoms with their sphere of oscillations occupy in different compounds different volumes;[2] the oxygen in the aldehydegroup occupies a larger volume than in the hydroxylgroup, the ratio being 1 : 0, 6. The atomic volume of nitrogen in the cyanogengroup is larger than in the nitrogroup and here again larger than in the amidogroup, the ratio being 1 : 0,50 : 0,13. And if the atomic volume of hydrogen were determined carefully in different combinations we should very probably find, that it occupies, in an aldehyde-and in an amidogroup a larger volume than in a methyl-and in a hydroxylgroup.

It will perhaps be not out of place to explain the nature of chemical lability in a few words.

A labil position exists, if in a molecule one atom is influenced simultaneously by the affinities of two neighboring atoms. Thus lively oscillations are produced bringing on a great ability for reactions and an inclination for a spontaneous migration of the labil atom into a stable position.

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1) Atoms moved simultaneously by heat and by chemical affinity must possess more energy than those moved by heat alone.

2) Unsaturated carbon compounds occupy a larger molecular volume than calculated from the numbers belonging to the saturated ones.—Aldehyde has further a larger specif. volume than the isomeric ethylenoxyde, the ratio being 56, 4 : 50, 6.

One of the most interesting labil atomic groups is the aldehydegroup $-C^{=O}_{-H}$, in which the oxygen exerts an attracting influence upon the hydrogen connected with the carbonatom, which is generally tetravalent, but can in some instances also functionate bivalent. Thus the hydrogenatom is subjected to continuous vibrations from the carbon to the oxygen and back, as may be indicated by the following formulas:

$-C^{=O}_{-H}$ (1) $\quad -C^{-O-H}$ (2) $\quad -C^{=O}_{-H}$ (3) $\quad -C^{-O-H}$ (4)

These motions are accelerated by rise of temperature; in the same measure the inclinations to chemical reactions increase. Ammonia, diamid, hydroxylamin, hydrocyanic acid, sulfuretted hydrogen, primary sulfites act with great facility upon aldehydes and even the molecular oxygen is taken up easily by certain aldehydes. Certain substances bring on a rapid change: thus a little sulfuric acid will transform ethylaldehyde into paraldehyde, a polymeric modification, whereby a contraction and development of heat takes place. Caustic potash converts that aldehyde into a resin.

Another group of a certain lability is represented by the following position:

$$\begin{array}{l} -C=O \\ \quad | \\ -CH_2 \end{array} \qquad \text{easily passing into:} \qquad \begin{array}{l} -C-OH \\ \quad \| \\ -CH \end{array}$$

One of the laws of lability can therefore be generally expressed thus: *If in a chain of carbonatoms one of these atoms has two affinities saturated by one oxygenatom, while the other two affinities of the same carbonatom are saturated by positive atoms or groups of atoms, a labil group is formed.* This lability is increased with the entrance of stronger positive groups and is lessened by negative groups; *amido*-benzaldehydes show a far greater lability as *nitro*-or *oxy*-benzaldehydes.

The saturated hydrocarbons, alcohols and acids of the methanseries are in comparison with the aldehydes very *stable* compounds; also the saturated hydrocarbons of the benzol series. The stability however decreases with the number of entering hydroxylgroups.

Now taking the proteids into consideration, it must be borne

in mind, that these are the most complicated combinations of all, and that up to the present day our slow inductive methods have not yet elucidated their chemical structure, although numerous facts relating to the decompositions under different circumstances have been discovered within the last ten years, especially by *Maly*, *Nencki*, *Drechsel*, *E. Schulze*. It was therefore not possible to look here for an explanation in regard to the constitution of the active albumen or proteids. A more promising way seemed to me to study at first the formation of albuminous substances within the life-plant, as it was most probable, that the active proteids were products of direct synthesis. In this regard an important observation made at first by *Th. Hartig* and later studied by *Borodin*, *Pfeffer*, *Kellner* and especially by *E. Schulze* put us upon the right track: the observation that in many cases of albuminous decompositions in plants *asparagin* is formed in surprisingly large quantities, and that this asparagin quickly disappears again in the formation of new proteids, without any intermediate product being discernible. (See Chapt. V.).

This led me to the conclusion, that *albumen* is formed by a rapidly proceeding *condensation*-process. But in order to render this possible, the asparagin had to be transformed first into an aldehyde, the aldehyde of aspartic acid, from which by condensation and reduction substances of the composition of albuminous matter could be formed, as may be expressed by the following equations:

I. $3(C_4H_7NO_2)=C_{12}H_{17}N_3O_4+2H_2O$

II. $6(C_{12}H_{17}N_3O_4)+12H+H_2S=\underbrace{C_{72}H_{112}N_{18}SO_{22}}_{\text{Simplest expression for albumen}}+2H_2O$

If the condensation were to take place between the aldehyde-and methylengroups and the hydrogen indicated in the equation II were to be used for reduction of 12 aldehydegroups, the *final product would still contain 12 aldehyde-and 18 amidogroups* and would therefore be of an *extraordinary lability*.[1] The energetic motions in such a product could bring on oxydative processes (see Chapt. VI.), in which easily oxydisable products as sugar, lecithin, could participate. This process might lead in

1) *O. Loew. Pflüg.* Arch. Vol. 22, p. 503.

the living protoplasm by regulating contrivances to the *respirationprocess.*

The question arises now: can it be proved directly or indirectly that aldehyde-and amidogroups are really present in the living protoplasm?—If our hypothesis is correct, that the vital motion emanates from labil aldehyde-and amidogroups, it follows, that every substance reacting in great dilution with those groups must prove a *poison for every living vegetable or animal organism.*[1]

As experiments confirmed this conclusion, our hypothesis of the formation and nature of active albumen has thus received essential support. Very correct views were expressed by *Nencki* in regard to the cause of poisonous actions.[2] "Why is it that a poisonous substance has a well defined action, while slight changes in the chemical constitution of the poison bring on quite different actions? This depends on the one hand upon the chemical constitution of the protoplasm and on the other hand upon the chemical structure of the poisonous substance." Indeed in most cases the poisonous actions are the result of a chemical reaction upon the albuminous substances of the living cells. If we lessen the *chemical* energy of a poisonous substance by introducing a carboxyl-,-or a sulfogroup, the physiological action will be also lessened. If we substitute alkyls for the hydrogenatoms of amido-or imidogroups the poisonous character is decreased; while on the other hand innocuous substances might turn into poisons if imidogroups, or amidogroups of a certain lability are formed. Thus the non-poisonous hydrobenzamid can be transformed by atomic migrations into the *poisonous* amarin, isomeric to the former.—

And what an enormous change in the poisonous qualities is observed, if one hydrogenatom of the ammonia-molecul is replaced by the hydroxyl,-or by the amido-group! While ammonia in form of neutral salts is in a certain dilution no poison for animals, the substitution-products thus obtained, viz. the hydroxylamin resp. diamid in the same dilution in neutral solutions are very strong poisons.—Bacteria and mouldfungi, that are not

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1) Compare *O. Loew*, A natural system of poisonous actions, Munich, 1893. Chapt. 4.

2) Arch des scienc. biolog. St. Pétersburg 1892 p. 61.

poisoned by concentrated solutions of neutral ammoniasalts, are easily attacked by hydroxylamin even at dilutions of 1 : 10,000[1]).

I found, that diatoms are killed within 24 hours by hydroxylamin in a dilution of 1 : 100,000 and that in a dilution of 1 : 20,000 it is a stronger poison for infusoria than strychnin! In a dilution of 1 : 15,000 it kills within a few days phaenogamous plants, as was shown by me with young plants of maize and helianthus and by *E. Schulze* with maize and barley.—*Marpman* observed later also the poisonous qualities for pathogenic microbes. In short, while ammonia is next to nitrates the most important source of nitrogen for the nutrition of plants, hydroxylamin never can be used for this purpose, being a deadly poison!—

In regard to lower animals I observed, that while sal-ammoniac in a dilution of 1 : 10,000 had no noxious effect upon crustaceans (copepodes) the equally diluted solution of hydrochlorate of hydroxylamin (neutralised with soda) killed them within 3 hours. A solution of 1 : 20,000 killed aquatic snails, worms, and larvae of insects within 36 hours.—*Raimundi* and *Bertoni*, *Binz*, *Lewin* studied the poisonous action on the higher animals. 0,05 g. of hydrochlorate of hydroxylamin kills a pigeon in 3 minutes; 0,1g pro Kilo. of a warmblooded animal will produce convulsions.

When the diamid was discovered by *Th Curtius* in the year 1887, and its remarkable affinities for aldehydes became known,[2]) I predicted at once, that this substance must prove a universal poison, a poison for all kinds of living cells. Indeed I observed afterwards that the neutralised sulfate in a dilution of 1 : 10,000 kills algae in 1-2 days; at 1 : 5,000 bacteria; at 1 : 2,000 infusoria, crustacea, mollusca and aquatic larvae of insects within 12 hours, while neutral ammoniumsulfate in this dilution produced not the slightest effect whatsoever. I found further, that young plants of Helianthus died within 4 days, and of barley within 2 days, if placed into a solution containing 0,2 p. mille neutralised sulfate of diamid, while the controlplants treated with equal quantities of ammoniumsulfate developed normally.[3]) 0,5 g. of

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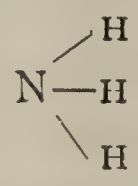
1) O. Loew, Pflügers Arch. Vol. 35, p. 515 (1885).

2) According to *Curtius* diamid attacks aldehydes even in strong acid solutions, while it combines with ketons only in form of the free base.

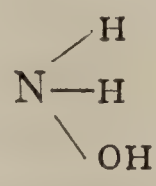
3) O. Loew, Berichte d. D. Chem. Ges. Vol. 23, p. 3204.

diamid sulfate will kill a rabbit in $1\frac{1}{2}$ hour (*Buchner*).

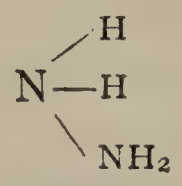
Why is it then,—it will be asked that hydroxylamin and diamid are such strong poisons compared with ammonia? The answer can only be found in the marked difference of behaviour to aldehydes (resp. Ketons). It has been demonstrated by recent investigations, that salts of hydroxylamin and of diamid (hydrazin) act even in high dilutions upon aldehydes while ammonia acts only as free base or as carbonate and with less energy. This difference is due to the *greater lability of the hydrogenatoms* in the former, attacking thus easier the labil oxygen of aldehydes and ketons.



Ammonia.



Hydroxylamin.



Diamid.

We find analogous differences of intensity of toxicological actions between anilin $C_6H_5.NH_2$ and phenylhydrazin, $C_6H_5.NH.NH_2$; between pyridin C_5H_5N and piperidin $C_5H_{10}.NH$; between phenol and amidophenol, which latter is,-*in accordance with the behaviour to aldehydes*,-also a stronger poison than anilin.—

The reaction between hydroxylamin and an aldehyde is expressed by the following equation:

$$\underbrace{(x)-C^{=O}_{-H}}_{\text{An aldehyde.}} + H_2N-OH = \underbrace{(x)-C^{=N-OH}_{-H}}_{\text{An aldoxim.}} + H_2O$$

It is of considerable interest, that also *certain derivatives* of *hydroxylamin* react easily with *aldehydes* and exhibit in accordance therewith a *poisonous character;* these derivatives are the "amidoxims," prepared by *Tiemann* by the action of concentrated hydroxylamin upon nitriles at higher temperatures:

$$\underbrace{(x)-C\equiv N}_{\text{A nitril.}} + H_2N-OH = \underbrace{(x)-C^{-NH_2}_{=N-OH}}_{\text{An amidoxim.}}$$

$$(x)-C^{-NH_2}_{=N-OH} + \underbrace{(y)-C^{=O}_{-H}}_{\text{An aldehyde.}} = (x)-C^{-N=CH-(y)}_{=N-OH} + H_2O$$ [1]

1) The product thus formed can undergo an atomic migration; *Tiemann*, Ber. 22, p. 3124.

One of the amidoxims, the benzenylamidoxim $C_6H_5-C^{-NH_2}_{=N-OH}$ was shown by *Mering* to be poisonous:

0,5 g. will kill a dog; 0,1 g. a rabbit; 0,03 g. a frog.[1]

But we observe also on the other hand that substances acting readily upon labil *amidogroups* are equally poisonous; above all may be mentioned the formic aldehyde, the free cyanogen, and the nitrous acid, which latter is far more poisonous than nitric acid. I observed that *formic aldehyde* CH_2O in a dilution of 1 : 10000 kills readily microbes and algae; of 1 : 2000 in 2 hours crustaceans, worms and mollusca.[2] Rabbits are killed by 0,24 g. pro Kilo. (*Zuntz*). Phaenogams watered with a 1 p. mille solution will die in from 2-6 days (*Bokorny*). This aldehyde annihilates also as I have found (Jahresber. f. Thierchemie 1888) the actions of the enzymes. The action on amines is shown by the equation:

$$H_2CO + H_2N-(x) = H_2C=N-(x) + H_2O$$

The *free cyanogen* is for lower vegetable and animal organisms a stronger poison than hydrocyanic acid; in a dilution of 1 : 5000 it kills cells of the bear-yeast, in dilution of 1 : 10000 infusoria and algae.[3] Its action upon labil amidogroups may be represented by the following equation:

$$\begin{matrix} CN \\ | \\ CN \end{matrix} + H_2N-(x) = \begin{matrix} C^{=NH}_{-NH-(x)} \\ | \\ CN \end{matrix} = \begin{matrix} C^{-NH_2}_{=N-(x)} \\ | \\ CN \end{matrix}$$

The action of *nitrous acid* upon labil amidogroups is shown by the following equation:

$$NO\,OH + H_2N-(x) = OH-N=N-(x) + H_2O$$

and:

$$OH-N=N-(x) = OH-(x) + N_2$$

Free nitrous acid in a dilution of 1 : 100000 kills algae within 48 hours (*Loew* and *Bokorny*[4]). Nitrites are poisonous in all those cases, where nitrous acid is set free by organisms, thus for plants containing free acids or acid salts, and for the

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1) Ber. D. Chem. Ges. 1885 p. 1054.

2) The great antiseptic properties of formic aldehyde were first observed by myself. Jahresb. f. Thierchemie 1888.

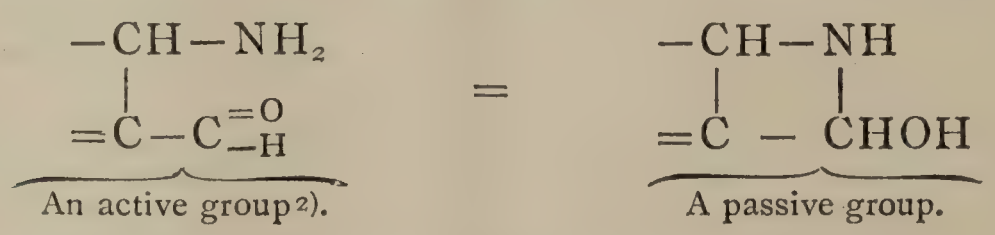
3) According to investigations which were carried on by myself and Mr. *Tsukamoto* in the laboratory of *Komaba*.

4) Botan. Zeitg. Dec. 1887.

higher animals. 0,03 g. sodium nitrite kills a frog, 0,05 g a rabbit (*Emmerich* and *Tsuboi*;[1]) *Binz*).

We observe therefore: The conclusion that the labil atom-groups in the living protoplasm are aldehyde-and amidogroups, agrees exactly with physiological phenomena, with toxicological facts, which cannot be said of the views of *Pflüger* and of *Latham* assuming the labil groups to be cyanogengroups. According to the view of *Pflüger* the chemical change connected with the loss of life consists in the chemical fixation of the elements of water, according to our view, however, in a migration of atoms from labil to stable position without water being taken up. Cyanides will react with hydroxylamin only in concentrated solutions and at higher temperatures, aldehydes however in the cold and in high dilutions. The poisonous actions of all the substances above mentioned, furthermore, are not in accordance with the cyanogen-hypothesis.

As labil amidogroups act readily upon labil aldehydegroups there arises a constant danger to the living cells themselves of an inter-molecular poisoning taking place; indeed we need only to heat the living organisms to 45-50° and death will result with rare exceptions; the continuous danger has become a reality. I expressed this chemical change by the following equation:



An active group[2]). A passive group.

Substances that contain simultaneously aldehyde- (resp. keton-) groups and amidogroups are indeed of an extraordinary lability and when I first published my views upon the formation of active albumen in plants (1880, *Pflüg.* Archiv.); no such combinations were yet known. But soon afterwards the orthoamidobenzaldehyde was prepared by *Friedlaender* and found to be a very reactive substance.

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1) These two bacteriologists have demonstrated that also the poisonous symptoms in cholera depend upon the formation of nitrites from nitrates by the cholera-bacillus.

2) Twelve of such groups are—according to my hypothesis of the formation of active albumen—contained in one molecule of the latter; if the simplest expression for albumen is taken as a foundation.

Later followed the preparation of paraamidobenzaldehyde and of amidovaleraldehyde.[1] Quite recently the amidoethylaldehyde was prepared by *E. Fischer*.[2] This substance is only stable in form of salts, and changes so rapidly after being set free, that it loses its power of reducing *Fehling's* solution within one hour, and becomes transformed into a gelatinous substance. Also the diamido-aceton soon changes spontaneously to an amorphous substance if set free from its combination with acids.[3] We observe therefore, that there exist labil amido-combinations which undergo spontaneously a rapid change,—losing thereby their original characteristics.—That here is a certain analogy to the change of protoplasm, when it passes from life to death, can hardly be denied if we see, that hydroxylamin and diamid, the most characteristic properties of which is their great ability to react in high dilution and at ordinary temperature upon aldehydes,—have *no longer any action upon dead protoplasm*, nor any influence upon ordinary soluble proteids at ordinary temperature.[4] —Those physiologists, who still cling to the old notions of the identity of proteids in the living and the dead protoplasm, will never have an understanding of the cause of the vital functions, they will be at a loss to conceive the method of poisonous actions!

If a change takes place from a labil to a stable character, if the cell dies, the reverse transformation must succeed, if by growing and multiplying animal cells pepton is resorbed for the formation of living protoplasm. Here kinetic energy is transformed into potential energy, passive groups become active ones. Labil combinations occupy a larger molecular volume than the isomeric stable ones, hence work must be produced by the conversion of the latter into the former. On the other hand contraction and development of heat will result if the active, labil albumen passes into the passive condition. Contraction of the protoplasm is indeed taking place with the death of the

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1) *Wolffenstein*, Ber. Deutsch. Chem. Ges. Vol. 25, p. 2777.

2) Ibid. Vol. 26, p. 92.

3) *Rügheimer* and *Mischel*, Ibid. Vol. 25, p. 1563.

4) It would be incompatible with the spirit of science to *avoid* the logical conclusions to which the toxicological facts mentioned, must lead. There exist physiologists who would declare all conclusions premature, but have they considered what good grounds exist for such an assertion?

cells [1]), and the heat developed on the death of larger cellular complexes like muscles can be measured with the thermometer.—

The vital phenomena depend upon the labil aldehydic character of the living protoplasm; this labil character gives rise to respiration. Respiration produces heat, and heat again increases the oscillations of the labil atomic groups in the living protoplasm, until a certain limit is reached. Hereby a transformation of heat into chemical activity results, the vital motion thus leads to vital functions. We propose to call the resulting vital motion: *plasmic force*, instead of vital force, which name would recall the erroneous conceptions of former times. We define therefore *the plasmic energy as a mode of motion produced by the labil atomgroups in the proteids of the living protoplasm and intensified by the process of respiration, induced by the labil character.*

However not only is the *chemical* structure of the proteids a labil one, but so also is the *morphological* structure of the protoplasm, the *tectonic*, i.e. the invisible arrangement of the molecules of active albumen to small particles of protoplasm, composing the organoids of the cells (nucleus, chloroplasts, filarplasm, tonoplast etc.).[2] *Slight* disturbances of a *mechanical* nature produce contraction and death. The *chemical* attack of a poison upon only a *minute* portion of the protoplasm of a living cell may cause the collaps of the entire protoplasm. The *morphological* construction and the *chemical* nature of the living protoplasm are evidently most intimately connected; an injury to one will also damage the other: *The living protoplasm is a labil structure built up of labil material.*

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1) Contraction of cytoplasm in plantcells is not observed however in some special cases, as treatment with absolute alcohol, acids and dilute caustic lyes. But an invisible contraction has nevertheless taken place also in these cases, as can be demonstrated by the loss of the osmotic qualities of the cytoplasm. The pores have become so large, that the osmotic membrane has changed into a filter, that now permits easily the exit from the vacuole of various substances, as tannin etc.

2) It is convenient to distinguish the invisible organisation as "tectonic" from the visible organisation, i.e. differentiation into different organoids of a cell.

CHAPTER IV.

Active Albumen as reserve-material in plants.

The facts described in the last chapter lead us immediately to the questions: Do the active proteids also exist as such, i. e. in the *non-organised* condition, in plantcells? If so, are they just as labil as in the *organised* state, i. e. as living protoplasm? Is it possible to obtain directly the chemical reactions upon the aldehydnature of those compounds?—To these questions *Dr. Thomas Bokorny* and myself have devoted considerable time and attention and our investigations[1] have shown: 1. That there exists in many plants, apparently in a state of solution a certain protein-substance quite different from ordinary proteids; 2. That this substance is capable of giving certain reactions, of which the living protoplasm on account of its great lability is incapable, and which neither dead protoplasm nor the known soluble proteids show; 3. That this substance is used up during the growth and multiplication of cells, and that it plays therefore the rôle of a reserve-material.

The reader will be made acquainted in the following lines with the principal observations relating to this discovery.[2]— Many vegetable objects, algae as well as parts of higher developed plants, show under the influence of weak bases like *coffeïn* (0,1-0,5%) or *antipyrin* (best in 0,5% solutions) a remarkable phenomenon, consisting in the appearance of a large number of minute transparent colorless globules,[3] that gradually unite

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1) Of our publications I mention here merely:

O. Loew and *Th. Bokorny:* Die chemische Kraftquelle im lebenden Protoplasma, Munich 1882.—

Botan. Centralbl. 1889, and 1893.—Biol. Centralbl. Vol 11.—

Flora 1892. p. 117.—

Dr. Th. Bokorny, now professor at the Military Academy in Munich, published contributions in:

Pringsheims Jahrb. Vol 19. and Vol. 20. *Pflüg.* Arch. Vol. 45 and Vol. 50.

2) I describe here the facts in the order, in which it appears most convenient for the reader to conceive. I neither enter therefore upon a sketch of the development of our investigations, nor upon a relation of the discussions brought on by our publications. Suffice it to say that the objections have been refuted as wholly unfounded.

3) Coffein acts still in higher dilutions than antipyrin.

into larger globules and droplets, losing thereby their original motions (*Brown's* so-called molecular motions?). As regards most of the objects these droplets are situated in the vacuole, in some however in the cytoplasm as well. All kinds of *Spirogyra*, an alga of common occurrence, are for these observations especially well adapted; they remain for some time—even for a series of days—alive in the solutions mentioned. If the objects, in which the droplets have been produced, are taken from these solutions and replaced in pure water, the droplets will gradually disappear again in proportion as the bases mentioned leave the cells by osmosis. The cells continue thereby their life as before the treatment. This dissolving process is quickened at higher temperatures, at 30°C. it requires but a few minutes. Replacement of the objects in the solutions of these bases makes the droplets reappear. If however the cells *die* by the prolonged influence of coffeïn or antipyrin, or if they are *killed* by dilute acids or by poisons like formic aldehyde, hydroxylamin, or salts of copper, etc., or by vapors of ether, then *these droplets* also *change their properties,* soon after the death of the cells. Hereby the close chemical *resemblance* of matter in the *protoplasm* and in the *droplets* becomes manifest. The droplets become turbid from numerous and minute vacuoles, formed by a sudden loss of absorbed water, and, in coagulating, *lose their solubility*.[1] In some cases the small vacuoles unite into one large one, a hollow sphere thus resulting, in other cases the spherical form is lost entirely, leaving an irregular shaped mass. In some objects the vacuoles disappear again by further contraction, and the globules again turn transparent; the insolubility however remains. This turning from the soluble into the insoluble state is a *decisive proof of a chemical-change.*—

It is of special interest to observe under the microscope the change brought on by the action of a 0,2-0,5 per cent solution of acetic or sulphuric acid or by a diluted alcohol of 10-20 per cent.[2]

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1) It is of rare occurrence, for the droplets to lose their solubility, *before* the death of the cells is observed in the above named solution of coffeïn or antipyrin.

2) If instead of diluted alcohol *absolute* alcohol is employed, the coffeïn is so rapidly extracted that the smaller globules dissolve before they are coagulated, while the larger ones shrink to irregular shaped thin films. Here the exosmose of coffeïn proceeds quicker, than the endosmose of a sufficient quantity of alcohol. All the experiments mentioned are best made with the *larger* globules; the changes cannot be well observed if the globules are too minute.—

Still more striking is the effect of the vapors of ether. If spirogyra-threads containing freshly produced droplets are exposed in a flask at ordinary temperature to the vapors of ether, the cells are found killed in a few seconds, and about 20 minutes afterwards all the globules change their aspect, losing their brightness and their solubility!

The coagulation by heat is easily observed if the objects are dipped in boiling water containing 5 per cent of chloride of sodium, all droplets exhibiting then a turbid appearance; neither boiling water nor absolute alcohol will change them any further. It is well known, that the presence of salts facilitates the coagulation of albuminous matters.

The substance in question is also changed quickly in the *dissolved* state, with the death of the cells; in dead cells coffeïn never produces any globules. If for instance we treat *Spirogyra Weberi* for one minute with a very dilute aqueous solution of iodine, the globules may be still produced by coffeïn immediately afterwards, but after 10 minutes action of the iodine, no more. That our substance had not left the dead cell by osmosis can be easily shown, if we add to the small quantity of the iodine-solution, in which we left a larger quantity of the algae to die, coffeïn in a sufficient quantity: no trace of the above described phenomenon is observed. The same experiment may be made with cells killed in any other way.

All these facts demonstrate beyond a doubt, that we have a peculiar protein-substance before us, distinguished from the ordinary soluble proteids not only by its being separable from the dissolved state in globules by coffeïn or antipyrin, but also by a very great lability, as these globules become coagulated by influences, which do not at all change the ordinary soluble proteids, as alcohol of 20 per cent or vapors of ether. We called these globules *proteosomes*, thus reminding us on the one hand of the proteids, on the other of the "microsomes." In the *coagulated* state they exhibit all the properties of ordinary coagulated proteids. Treated with phosphortungstic acid (10 per cent) they remain insoluble even after weeks, while hydrochloric acid of 10 per cent changes them gradually and dissolves them after a series of days at ordinary temperature.—A solution of caustic soda or potash of moderate strength soon dissolves the

proteosomes, but if they had been treated with a neutral solution of formic aldehyde (5-10 per cent), they would have lost their easy solubility in caustic lyes,—exactly like the behaviour of ordinary proteids, I observed some time ago.[1]—The *Millons* reaction is obtained if the objects are left for 8-10 hours in a solution of mercuric nitrate containing some potassium nitrite, and then heated for a short time to the boiling point.—The "biuret-reaction" is obtained on treating the proteosomes first with diluted ammonia (0,1 %), then for 12 hours with a dilute solution of acetate of copper, and finally with dilute caustic potash.[2]—While the fresh proteosomes soon disappear by treatment with dilute carbonate of soda, such proteosomes, as were changed by the death of the cells, offer considerable resistance to it.

Of special interest is the behaviour to diluted ammonia, whereby the proteosomes are *solidified*, another and marked difference from ordinary proteids being thus demonstrated.[3] These solidified proteosomes are chemically not identical with the coagulated proteosomes mentioned before; the ammonia brought on a different change, being taken up and having entered into an intimate combination, which however has no salt-like constitution, as the chemical behaviour clearly indicates. A dilute hydrochloric acid (0,5 per cent) will at 40°C gradually attack the coagulated proteosomes, but not those solidified by ammonia. Even a 10 per cent hydrochloric acid dissolves at 80° the latter ones with difficulty, compared with the former. This chemical fixation of ammonia recalls the formation of pyrrols from 1.4 diketons or the formation of aldehyde-ammonia-groups, with subsequent changes to a more intimate fixation of the nitrogen. If aldehyde-groups be present in our labil proteosomes, the behaviour towards ammonia can be understood, and as aldehydes retain their silver-reducing properties even after combining with ammonia, this question could be settled by experiment. But care had to be taken to exclude every trace of other reducing compounds as glucose or tannin, frequently occurring in plant-cells.—

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1) Compare *O. Loew*, Jahresbericht f. Thierchemie 1892 p. 29 and 1888 p. 273.

2) For further details see Botan. Centralbl. 1889 Nr. 39 and 45.

3) This behaviour to ammonia may serve in some cases to distinguish small and indistinct proteosomes from tannates of coffeïn or antipyrin, which will be readily dissolved by ammonia.

To select objects free of glucose, is not difficult, but rarer are such as unite with an abundance of proteids the absence of tannin, seemingly a frequent by-product in the synthesis of proteids. It collects in the proteosomes in combination with albumen.—We have shown however, that tannin might be used as a source of carbon in the formation of proteids *under favorable circumstances*. These experiments were made with *Penicillium*, cultivated in nutrifying solutions containing as sole organic substance tannin. The produced mass of the fungus amounted to 12,4 per cent of the tannin applied, after a growth of four weeks, at the end of which time no trace of tannin was present any longer.[1] This result led us to experiments with *Spirogyra*[2] and indeed the tannin disappeared, the best reactions failed finally, and when the cells were boiled with a little water, neither the acqueous liquid nor the cells themselves showed any reaction with a 1 per cent solution of nitrate of silver supersaturated with ammonia; hence it was evident that neither a soluble nor an insoluble reducing substance was present any longer in the *killed* cells. Still, the proteosomes were capable, even after treatment with ammonia (1 p. m.), of *reducing even very highly diluted alkaline silver solutions*, the globules thereby turning *black*. Such proteosomes however as were changed by acetic acid, or by any other death of the cells were found incapable of reducing the same silversolutions, even after 24 hours contact. This silver reagent was always left with the objects in the dark, and was applied in a highly diluted state, because it is characteristic of aldehydegroups, to bring on a silver reduction in far greater dilutions, than many other reducing substances or atomic groups. A suitable silver solution may be obtained by supersaturating 1 cc. of a 1 per cent solution of silver-nitrate with ammonia, adding a few drops of a diluted solution of caustic potassa and diluting this mixture to one liter with distilled water. This solution contains 100000 parts of water for 1 part of silver-nitrate employed (present now as oxyde in solution) and is still easily affected by aldehydes.

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1) Botan. Centralbl. 1889 Nr. 39.

2) The smaller kinds of Spirogyra are sometimes found also in nature free of tannin. Of the larger kinds most tannin is found in Sp. crassa and Sp. majuscula, which therefore are not so favorable for these experiments, as other kinds.

The solution, in which we cultivated *Spirogyra nitida* and *Sp. Weberi* for the purpose of making the tannin disappear, contained: calcium-nitrate, magnesium-nitrate and potassium-sulphate, 0,05 per cent of each, monopotassium-phosphate 0,005 per cent and a trace of chloride of iron. A few threads were placed in a liter of this solution, which was at a temperature of 15—16° left, exposed to only a moderate amount of light for 2—3 weeks.[1)]

An object entirely free of tannin or related compounds are the snowberries (Symphoricarpus racemosus). If the fleshy tissue of unripe snowberries be treated first with coffeïn, and the proteosomes be left in diluted (0,1 per cent) ammonia, the tissue then washed with tepid water to remove every trace of sugar, we observe also here an intense blackening of the proteosomes by the silver reagent mentioned.

The question, whether our labil proteosomes represent the active albumen of our theory is easily proven. If favorable conditions for growth and multiplication of cells were offered and at the same time the formation of new albumen was made impossible, then the reserve-albumen had to be used up gradually. We shall indeed observe this result if we cultivate for instance threads of Spirogyra in a comparatively large volume of the following solution:

0,05 per cent calcium sulfate,
0,02 „ „ calcium bicarbonate,
0,02 „ „ magnesium sulphate,
0,005 „ „ monopotassium phosphate,
Small trace of chloride of iron.

In this solution were present all the mineral constituents necessary for development, except every suitable source of nitrogen, hence new albumen could not be formed and the reserve albumen had to be seized upon for the organisation of growing protoplasm, for the nucleus and chlorophyll-bodies of the new cells. Indeed the stored-up albumen disappears here so perfectly, that coffeïn fails to produce proteosomes after 2-3

1) Hereby the quantity of originally present active albumen is found relatively decreased in the cells, on account of their multiplication, but the proteosomes produced remain perfectly colorless, if the threads are left to die in a solution of ferrous sulphate; a proof, that every trace of tannin was used up.

weeks of cultivation. The albumen of our proteosomes therefore serves for building up protoplasm.—If we place now the same threads in a solution containing *potassium-nitrate*, as for instance in:

0,05 per cent potassium nitrate,
0,03 ,, ,, calcium nitrate,
0,005 ,, ,, magnesium sulphate,
0,005 ,, ,, monopotassium phosphate,
trace chloride of iron,

we obtain after 3 weeks with coffeïn an intense formation of proteosomes, more active albumen having been produced than was required for organisatory purposes. Potassium nitrate is not only a suitable source of nitrogen, but the potassium of this salt is also important for the chlorophyll function, yielding an increased quantity of starch for the synthesis of proteids. *Spirogyra majuscula* forms in this solution after several weeks such large quantities of active albumen, that this commences in some cells to separate in globules even without the coffeïn-treatment.—

Also changes of temperature have a great influence. Hot weather favors growth and the active albumen may be more quickly used than formed; hence a decrease of the reserve-albumen; if now cold weather follows, growth is more retarded than the synthetical preparation of proteids, hence an accumulation of active albumen results.[1]—Also phosphates interfere with the accumulation. In the absence of these salts (other conditions being favorable) albumen will continue to be formed, but organisation and multiplication of cells will have stopped, hence accumulation increases.[2]

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1) It was quite natural for us to take, at the beginning of our studies, the proteosomes of the cytoplasm for an essential part of the protoplasm, as it was not known before, that dissolved proteids occur as reserve material in the living protoplasm itself. The recent attack of *P. Klemm* upon our definition of active albumen (Bot. C. March 1894) contains no arguments, but merely a series of assumptions disregarding the main facts we described, especially the most important change of the proteosomes as soon as the cells are killed in one way or other.

The state of *copulation* does not depend upon the amount of stored up active albumen; I have observed in some cases much of the latter, in other cases none at all.—

2) *O. Loew*, On the physiological functions of phosphoric acid; Biolog. Centralbl. Vol 11. p. 280.

Active albumen can be stored up in higher and lower plant-forms and in most different parts of plants. Thus we obtain proteosomes by coffeïn or antipyrin with leaves of all insectivorous plants except with *Utricularia*. *Drosera* shows it in all parts of the leaves, stem, and flower.[1] The most remarkable however among all insectivorous plants is in this regard *Cephalotus*, containing in all parts astonishing quantities of stored-up active albumen. Further objects are: The subepidermial cells of the leaves of *Crassulaceae* as Cotyledon, Echeveria, Sedum; the epidermial cells of Primula sinensis and Pelargonium; the hairs of the stems of Begonia and of many other plants; the petals of Cyclamen, Cornus, Tulipa, Epidendron; the anthers of Eugenia, Melaleuca and Forsythia; the pistils of Crocus vernus, Rhododendron, Salix, Euphorbia; the peduncles and petals (sometimes also young seeds) of:

Gentiana, Primula, Scrofularia, Impatiens Sultani,
Hoteia japonica, Pirus Malus, Prunus Cerasus,
Amorphophallus Rivieri, Viburnum rugosum,
Sorbus aucuparia, Thea chinensis;
the flowers and young leaves of Rheum, Acer, Populus, Acacia, Crataegus oxyacantha, Mimosa pudica; the nectaria of Passiflora.

In some plants it is found only at certain stages of development, as in the petals of malvae, in unripe snowberries (Symphoricarpus racemosus), in cotyledons of Helianthus, in the larger cells of Vallisneria-leaves.

Whether fungi ever store up active albumen as a reserve-material is still doubtful;[2] among the algae are the various kinds of Spirogyra the most noticeable ones, Vaucheria contains it occasionally, Mesocarpus, Oscillaria, Oedogonium, Sphaeroplea, Palmella, Desmidiaceae and Diatomeae never, so far as our observations reach. Of higher organised plants not containing this reserve-material may be mentioned: Leaves and roots

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1) The socalled *aggregation* observed first by *Darwin* with the tentacles of *Drosera* is a different process, but *Bokorny* has shown, that there exist certain points of connection between the two phenomena. Compare *Pringsheims* Jahrb. Vol. 20 p. 465.

2) We have however observed silver-reduction in black dots with spores of Gymnosporangium, and with Saccharomyces cultivated at low temperature in a solution free of sugar.

of Poa; shoots of Pisum and Vicia; leaves, stems, and flowers of Tussilago, Ranunculus, Veronica, Convallaria.

The active albumen may serve not only for the growth of protoplasm, but also for the formation of enzymes. It may be changed into passive albumen and then form the aleuron grains and protein crystals, as seems to be indicated by an observation of *Peters*, who reports: "The formation of protein crystals proceeds in cells of Sparganium and Carex in the interior of a *drop-like accumulation* of protein matter by the crystallisation-process."[1] The passive proteids as reserve-material in the seeds are most probably always products of change of previously formed active proteids.—

In the animal kingdom no such highly labil, dissolved *reserve*-proteids, are found; at least the coffeïn-reaction cannot be obtained. Easily changeable albuminous substances of another character as the active albumen described occur; the proteids of the bloodserum causing the artificial and natural immunity, as the highly important investigations of *Emmerich*, *Tsuboi*, *Buchner* have shown, and the poisonous proteids of snakes and of the blood of eels may be mentioned in this regard. Also the enzymes or soluble ferments belong to the labil proteids. I have observed, that these latter substances lose their efficacy by treatment with a neutral diluted solution of formic aldehyde, which may be considered as an indication that labil amidogroups play an important rôle in their active condition.[2]—

The mode of action of coffeïn or antipyrin upon the vegetable objects mentioned above, consists probably in the formation of very loose combinations of these bases with the active albumen, whereby the original chemical nature of the latter is otherwise not altered, combinations which are less soluble than each of the constituents for itself. But also the hypothesis is admissible, that these bases lead mainly to a loose kind of polymerisation by an irritating influence. Be this as it may, at least it cannot be disputed that the original condition is restored by washing out

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1) Botan. Centr. Vol. 48, p. 181. Interesting are also some observations of *Molisch*, *Mikosch* and *Chmielewsky*, relating to the occurrence of spindle-and ringlike bodies of albuminous matter in the leaves of Epiphyllum and Oncidium, Bot. Centr. 1890, II. 341.

2) O. Loew, Jahresbericht f. Thierchemie, 1888, p. 273.

these bases, which remarkably easily and without producing injury can penetrate the living protoplasm. It is different however, if we apply stronger bases (and their salts), as for instance: guanidin, methylamin, propylamin, anilin, toluylendiamin, atropin, amarin, piperidin, coniin, nicotin, chinin, strychnin, morphin, codeïn, chinolin or pyridin in 0,1-0,3 percent solutions. Here also we observe granulations, but they do not coalesce to droplets, and solidify soon, becoming entirely insoluble in water. The protoplasm itself is also attacked with more or less energy by all these bases and killed quickly by chinin and strychnin, more slowly by morphin, atropin or pyridin.[1])—Of inorganic bases: ammonia and its carbonate, hydroxylamin, caustic soda, and caustic potash produce like results: very minute granulations and quick death of the cells. But these bases have to be applied only in 0,1-0,01 per cent solutions for a production of a more intense granulation; a 1 per cent solution of ammonia will yield a lesser granulation, than a 0,2 p. mille solution; and a 5 per cent solution will change the active albumen so rapidly that no granulations at all result. Very dilute caustic potassa produces a more intense granulation than a corresponding solution of caustic soda; but neither carbonates nor secondary phosphates of these two bases, nor limewater can produce any granulations worth mentioning.

We have seen, that a highly labil, easily changeable albuminous substance is often stored up in plant-cells, that it is used up in growth and multiplication of cells, and that it behaves towards ammonia and alkaline silversolution like an *aldehyde*. We have found on the other hand (Chapt. III), that a series of toxicological facts point to the presence of *aldehyde*-groups in the proteids of the *living protoplasm*. This leads us to the logical conclusion, that our labil reserve-albumen is the very substance which yields by the organisation-process the living protoplasm, that it is active albumen, chemically but not morphologically identical with the active albumen of the living protoplasm. That this active albumen in the not-organised state is a little less labil, than in the organised state is intelligible, it brings on

1) Nitrogenous substances deficient of basic qualities do *not* produce proteosomes, as: skatol, hydrobenzomid, dimethyloxypyrimidin, leucin, tyrosin, asparagin, allantoin, kreatin.

some reactions, of which the living protoplasm is not capable on account of changing too quickly.—As to the great difference between the active and the passive albumen, convincing evidence has been furnished, and we recall here the more striking points of this chemical difference:

1. The power of combining with water is greater with the active than with the passive albumen;

2. Coffeïn and antipyrin exert action upon the active, not upon the passive albumen;

3. Alcohol of 10-20 per cent, vapors of ether, very dilute acetic acid, change the active, but not the passive albumen;

4. Active albumen absorbs ammonia and turns thereby insoluble, while passive albumen remains indifferent.

5. Active albumen reduces highly diluted alkaline silver solutions, passive albumen does not.

On the Poisonous Action of Di-cyanogen.

BY

O. Loew, and M. Tsukamoto.

Modern investigations lead to the conclusion, that the protoplasm of living cells is a labil organisation of labil material.[1] According to the theory advanced by one of us (L.) the great lability of the albuminous matter composing the living protoplasm is caused by the simultaneous presence of aldehyde- and amido-groups. If this is correct then every substance that can react in a high dilution upon aldehyde- or amido-groups must be poisonous for every living cell and organism, from the lowest fungus to the highest animal. Many toxicological facts and recent experiments are in accordance with this conclusion. The highly poisonous action of hydrocyanic acid may be best explained by its easy reaction with aldehyde-groups, while the poisonous action of di-cyanogen can be best explained by its action on labil amido-groups. The former reaction is represented by the following equation:

$$(x)-C\overset{=O}{\underset{-H}{}}+HCN = (x)-C\overset{\nearrow OH}{\underset{\searrow H}{-CN}} ,$$

and the cyanogen reaction by the following example:

$$2(C_6H_5NH_2)+\overset{CN}{\underset{CN}{|}} = \overset{C_6H_5N=}{H_2N-}C-C\overset{=N.C_6H_5}{\underset{-NH_2}{}} .$$

However, the poisonous action of these two substances has been studied so far only in regard to vertebrate animals, and in regard to the lowest forms of life only the action of hydrocyanic acid on yeast cells has been the object of closer observation. It seemed, therefore, of some interest to compare representatives of all kinds of living organisms as regards their behaviour to the two above stated substances.

We prepared solutions of di-cyanogen and of hydrocyanic acid of a certain strength. The di-cyanogen was prepared in

1) Compare O. Loew, Natürl. System der Giftwirkungen, Munich, 1893.

the usual way by heating cyanide of mercury; the aqueous solution, obtained by passing the washed gas in water, was analyzed in the following way:—20 c.c. of that solution were mixed with 2—5 c.c. of concentrated soda lye, and when, after some time, the cyanogen smell had disappeared, a silver-nitrate solution was added and afterwards supersaturated with nitric acid. The washed cyanide of silver was weighed on a dried filter. The calculated quantity of cyanogen was multiplied by 2, because half of the di-cyanogen having been converted into sodium cyanate was excluded in this determination. Thus was found in one case the percentage of cyanogen 0.37%, in another preparation 0.64% and in the third 0.39%. These solutions were kept cool, generally below 10°C, and were used only during the following four or five days for experiments,[1] because the solutions of di-cyanogen undergo a gradual decomposition. In comparing the di-cyanogen solutions with those of hydrocyanic acid, solutions of equal strength have been used, starting with the fact that two molecules of hydrocyanic acid (54) act upon two aldehyde-groups, while one molecule of di-cyanogen (52) reacts upon two amido-groups.

Action of Di-cyanogen upon Microbes.

To 50 c.c. of the cyanogen-solution of the dilution of 1 : 5000 a drop of putrid meat-water was added, and after standing 24 hours, a sterilized peptone-solution was infected from this aqueous liquid. After standing 8 days there was no bacterial development and no putrid smell perceptible. In the control experiment, in which water was used instead the cyanogen solution, after 3 days a strong development of bacteria with a putrid smell was observed.

In the second experiment in which was compared di-cyanogen and hydrocyanic acid both in dilution of 1 : 10000 a bacterial developement was observed in both cases, but not till 4 days later than in the control case, which seems to indicate that the bacilli themselves were killed but not the spores. In the third experiment some peas were placed in a cyanogen solution and in a hydrocyanic acid solution of equal strength, both of them in a dilution of 1 : 5000. After three days a very strong develop-

1) The Nessler's test showed us, that during the time, we experimented with these solutions, no decomposition with formation of NH_3 could be observed.

ment of bacterial vegetation was seen in the control flask, while in the flask of hydrocyanic acid solution a slight incipient turbidity indicated a beginning of vegetation, and in the case of cyanogen the liquid remained entirely clear and unchanged. Several other experiments have been made in a dilution of 1 : 5000 and 1 : 3000, and in each case the poisonous action of the two substances upon bacteria was clearly observed.

In another experiment, 1 gram of peptone was dissolved at ordinary temperature in 100 c.c. of a 1 : 1000 solution of hydrocyanic acid. After filtration, it was infected from putrid meat. At the same time, 1% solution of peptone was infected from the same source. After standing five days the latter solution showed a putrid smell, and white flocculent masses consisting of numerous bacteria, while in the first case no trace of turbidity or of putrid smell could be observed and no bacteria were found on examining under a microscope.

In a further experiment, 1 : 1000 solutions of di-cyanogen and hydrocyanic acid containing 1% of kreatin, 0.1% of di-potassium phosphate and a drop of a 10% solution of magnesium sulphate were infected from a vegetable matter in lactic fermentation. After standing a fortnight in closed vessels at ordinary temperature, these liquids[1] were perfectly clear and free from bacteria,[2] while the control solution showed a strong development.

The poisonous action of hydrocyanic acid for bacteria was also proved by the observation of Liebig,[3] that blood does not undergo putrefaction for a considerable time, when 1/1000 of its weight hydrocyanic acid is added. He also observed, that yeast-water did not putrefy when some hydrocyanic acid was added to it.

Action of Di-cyanogen and Hydrocyanic Acid upon yeast Cells.

Some thick yeast[4] obtained fresh from a brewery was mixed with a di-cyanogen solution of 1 : 2500 and after frequent

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1) At that time the di-cyanogen and prussic acid remained unchanged and were perceptible by smell.

2) According to E Schaer the development of mould fungi can be prevented by hydrocyanic acid in a dilution of 1 : 10000 (Zeit. f. Biologie 1870, Bd. 6, S. 509.)

3) Ann. der Chemie u. Pharmacie 1870, Bd. 153, S. 137 etc.

4) The yeast-mass of the size of a pea corresponding to in average 0.07—0.1 grams dry matter was shaken with 50 c.c. of the solution.

shaking the supernatant liquid was after 24 hours poured off. The sediment of yeast was then shaken with 5 c.c. sterilized Pasteur's solution[1] and placed in a narrow test-tube. No trace of fermentation was observed even at a temperature of 30°C, while in the control experiment a vivid fermentation was going on after half an hour. In a second experiment about the same amount of yeast was mixed with a di-cyanogen solution in a dilution of 1 : 5000, respectively 1 : 10000 (30 c.c.), and left to stand, being frequently shaken, for 20 hours. The liquids were poured off from the yeast and the latter was mixed with 10 c.c. of sterilized Pasteur's solution at 25°C. No fermentation was observed after 3 hours with yeast that had been treated with di-cyanogen solution of 1 : 5000, but later a few small gas-bubbles developed, although even after one day the development of gas was very slight, while in the control experiment after 15 minutes a strong fermentation had set in. On the other hand, in the case of the yeast having been in contact with the cyanogen solution of 1 : 10000 only 20 gas-bubbles developed in 1 minute after being 15 minutes in Pasteur's solution at 25°C, but more than 200 gas-bubbles were observed in the control case in the same duration of time.

In another experiment it was found that every trace of the fermentative action was annihilated after 24 hour's contact of yeast with di-cyanogen solution of 1 : 2000, while in several experiments with hydrocyanic acid the fermentative action was not annihilated. When the yeast was suspended for 24 hours in a sugar solution[2] containing hydrocyanic acid in a dilution of 1 : 1000, as long as hydrocyanic acid was present no fermentation was observed, but as soon as it was removed and the yeast settled at the bottom was shaken with plain sugar solution, the fermentation was almost as energetic as in the control mixture. This observation confirms those of Schönbein,[3] Schaer[4] and Liebig (l. c.), that hydrocyanic acid of a certain strength will paralyze

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1) Instead of the tartrate of ammonia however extract of meat was used.

2) This solution contained 5% cane sugar, 1% extract of meat, 0.1% KH_2PO_4 and a trace of magnesium sulphate and was mixed with so much prussic acid that the percentage corresponded exactly with the stated amount.

3) Zeitsch. für Biologie 1867, Bd. III, S. 142.

4) Ibid. 1870, Bd. VI, S. 503.

the fermentative action of yeast without killing it. But we have found further that if the hydrocyanic acid of the same strength remains in contact with yeast for more than one day, or if, instead of hydrocyanic acid solution of 1 : 1000 a stronger solution is applied, as 1 : 400, it will damage the fermentative activity so much that afterwards the yeast produces only a very faint fermentation. It seems to us that only a few yeast cells escaped death under these circumstances. We have found furthermore that 2 day's contact with hydrocyanic acid in a dilution of 1 : 5000 with frequent shaking, will kill almost all the cells, so that after pouring off the hydrocyanic acid, the yeast being shaken up in sterilized Pasteur's solution showed only very slight indications of fermentative action.

If we compare this result with our further observation that the fermentative action is not suppressed when we add to the mixture of yeast and Pasteur's solution prussic acid in the proportion of 1 : 5000, we are led to the conclusion that in all probability the hydrocyanic acid upon entering the yeast cell undergoes decomposition before it can act poisonously. If, however, the yeast is not in fermenting activity, the entering hydrocyanic acid is not so quickly decomposed, and therefore acts as a slow poison. It may perhaps be assumed that the change consists in the addition of H_2O, forming thereby formamid:

$$HCN + H_2O = HC^{=O}_{-NH_2}.$$

Action of Di-cyanogen and Prussic Acid upon Algae.

If threads of Spirogyra communis are treated with a solution of di-cyanogen of 0.39%, instantaneous death with contraction and turbidity of the cytoplasm is observed. In solutions of di-cyanogen, respectively hydrocyanic acid of 1 : 1000, no noxious effect was seen after 30 minutes, but after 4 hours most of the cells in the cyanogen solution were killed; in the prussic acid solution, however, a much smaller proportion of cells. After 15 hours, all the cells were dead in both cases. Also solutions of 1 : 10000 exerted a poisonous influence after several days [1], but it could

1) In another case the noxious effects of the two substances in the same dilution were observed after 20 hours; on treating with very dilute methyl violet the cells of the algae in the cyanogen were all coloured, but of those in the prussic acid some cells not, showing these were still alive.

be distinctly seen that HCN was less noxious than di-cyanogen. In a dilution of 1:100000 of di-cyanogen Spirogyra, Oscillaria and Diatoms were seen alive after several days.

Action of Di-cyanogen and Hydrocyanic Acid upon Phænogams.

In a solution of prussic acid 1 : 1000 which had no reaction upon litmus paper, some young radish plants 4 cm. high were placed. After 15 hours, leaves and stem had withered, lost the turgor, and commenced to dry up. Di-cyanogen solution of 1 : 5000 acted almost as quickly upon young barley plants with stems 10 cm. high. Even in a solution of di-cyanogen of 1 : 10000 young barley plants 5—6 cm. high were attacked after 3 days, turned yellowish, and commenced to dry up. In 200 c.c. of cyanogen solution 1 : 25000, to which were added the necessary mineral salts in the usual proportion, was placed a young water-cultured lupin-plant with a stem 8 cm long. After 20 hours the stem was bent down, and also the leaves without any turgor. After further 15 hours, however, the plant seemed to recover, but only for a short time, for 20 hours later the plant commenced to dry up. In another experiment, a stem of Narcissus (N. tazetta, var. chinensis, Roem.) was cut immediately above the bulb and placed in a solution of di-cyanogen in 1 : 10000. In this case no noxious effect was observed, evidently there was so much dissolved albuminous matter encountered in the juice by the cyanogen that this poison could not reach enough cells to kill the plant.

Some experiments were made with seeds that were just beginning to germinate after having been soaked in water. Thus the seeds of peas, turnips, radishes, and barley were treated with cyanogen-respectively hydrocyanic acid solution of 1 : 5000, in each case 12 seeds being placed in 50 c. c., and left to stand for 3 days in closed vessels. Control experiments with distilled water were also made. After pouring off the liquid, the vessels were left to stand at 15°—20°C; after 24 hours great differences were noticed: in the control experiments the seeds developed in the normal way, the others, however, remained stationary[1].

1) Schoenbein treated some seeds for half an hour with very diluted prussic acid and found that most of these seeds did not germinate any more. Some of the seeds, however ,germinated imperfectly (Zeitschrift. f. Biol. 1867, Bd. 3, S. 142—3).

Only in one case, where the turnip seeds had remained in the hydrocyanic acid solution, the development of the cotyledons was observed after 6 days while the life of the root-germ was entirely destroyed. Here probably the hydrocyanic acid did not enter far enough into the seeds to kill all the cells, while the root-germs were more exposed.

Action of Di-cyanogen and Prussic Acid upon Lower Aquatic Animals.

When under the microscope infusoria, nematodes, rotatoria, annelides, Copepodes, and Ostracodes were brought into contact with several drops of dicyanogen-solution in a dilution of 1 : 2000, all the life was annihilated within two minutes, while in a parallel experiment with an equal dilution of CNH the animals were alive after 30 minutes, but some time afterwards died under convulsions[1]). In di-cyanogen solution of 1 : 10000 (200 c. c.) the death of these animals very soon took place, also; only the worms lived longer, but after 15 hours they also died. In hydrocyanic acid of the same dilution the animals lived longer than in the cyanogen solution, and still after 15 hours ostracodes showed convulsions in their legs. Even in the dilution of 1 : 100000 of dicyanogen all infusoria with the exception of some monadines were killed. Also the copepodes died, but the ostracodes and worms still showed convulsions. In hydrocyanic acid of the same dilution many infusoria were alive after 5 hours, and some even after 18 hours. In a second experiment with some mud rich in infusoria (*Paramaecium*) some individuals were found alive after one hour in cyanogen solution of 1 : 20000, but all were killed after 20 hours even in the solution of 1 : 100000, while in the case of hydrocyanic acid in the same dilution many infusoria were left alive.

We see, therefore, that all these experiments prove the di-cyanogen to be a stronger poison than hydrocyanic acid; and, therefore, the results of *B. Bunge*[2]) with vertebrate animals, that

1) The assertion of Schaer (Zeit. f. Biol. 1870, Bd 6, S. 511), that infusoria are not killed by HCN is certainly erroneous. It may be that only an experiment of short duration under the microscope had been made. In our experiments with infusoria ordinary well-water was used for the dilutions.

2) According to B. Bunge (Arch f. exper. Path., Bd. 12, S. 41-75, or, Jahresb. f. Anat. & Physiol., 1879, Bd. 8., Ab. 2, S. 187), small doses of cyanogen produce general central paralysis. With warm blooded animals dyspnoe, and paralysis of respiration are produced. For killing a cat 0.02 grm. cyanogen are necessary while of prussic acid 0.004 grm. suffice.

hydrocyanic acid acts about 5 times stronger than di-cyanogen, seems to us exceptional. One experiment, which we made with two white rats, proved indeed that here hydrocyanic acid is much stronger. The one rat weighing 124 grams received by subcutaneous injection 1 c.c. of hydrocyanic acid solution 1 : 10000, the other rat weighing 156 grams received an equally diluted solution of dicyanogen (1 c.c.). The former rat was found dead after 10 hours, the latter, however, remained alive and healthy. The fact that the di-cyanogen here acts less powerfully is probably due to the fact, that free cyanogen can directly act upon proteids in solution,[1] and therefore can be changed to a great extent in the blood and lymph, before it reaches the nervous centres. Hydrocyanic acid does not act at all upon the ordinary *passive* proteids, and can, therefore, without being prevented by the serum albumen, reach the nervous centres,and act there upon the active labil proteids of the living protoplasm.

As the general result we see, that the prediction that free cyanogen would prove a general poison for all kinds of living organisms, has been confirmed. At the same time, it has been shown that also hydrocyanic acid is a general poison and we hope therefore that the explanation, which we have given above, will prove more durable than the former unsatisfactory hypotheses.[2]

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1) Compare: O. Loew, on the action of di-cyanogen upon albumen, Journ. f. prakt. Chem., 1877.

2) The former hypothesis that hydrocyanic acid acts poisonously merely on account of combining with the haemoglobin has been proved erroneous (J. Belky, Jahresb. f. Thierchemie, 1885, Bd. 15, S. 155).

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The Energy of the Living Protoplasm.

BY

Dr. Oscar Loew,

Professor of Agricultural Chemistry.

CHAPTER V.

The Formation of Proteids in Plant-cells.

The formation of albuminous matter in plant-cells is certainly one of the most important processes in the domain of general physiology, as it is upon this process that depends the growth of protoplasm, the multiplication of cells, the development of plants; upon plant-life again subsists all animal life. This remarkable synthesis takes place in fungi just as well as in chlorophyllaceous plants; but while the latter use principally the carbohydrates as sources of carbon, the former make use of a variety of organic compounds. We consider first:

The Formation of Protein in Microbes and Mould-fungi.

Among all the fungi the *microbes* are especially remarkable for the intensity of their chemical activity. Oxidations and decompositions take place on an extensive scale. Numerous organic combinations are easily split and, under atomic migrations, substances of a more solid structure are formed: the products of fermentative actions. And amid this destructive activity there is built up in the interior of the cells the most labil of all combinations, the active albumin, which is organised into living protoplasm. And this is done under favorable conditions with such rapidity that one cell yields by multiplication in 24 hours more than one trillion of new cells. What an energetic synthesis of protein-matter, of preparation of living protoplasm, of living cells! The destructive operations are necessary to carry on the synthetical work, furnishing not only energy but also the required atomic groups; and consisting either in oxida-

tions or in fermentations. We leave in this chapter, however, the fermentative activity out of consideration, and mainly treat of the protein formation and nourishment of the *aërobic* microbes and mould-fungi:—We observe here that a great number of organic compounds of different chemical constitution may serve for nourishment and development. There can be hardly any doubt but that in all these different cases the same proteids result, otherwise the structure and the functions of the protoplasm formed would show variations, new species would spring into existence with ease, according to difference in food. We find however the same species of a bacterium[1] or of a mould-fungus, whether we nourish them once with peptone, or with sodium tartrate as a source of carbon, whether we offer glycerin, glucose or lævulose, xylose or arabinose, glycol or chinic acid. It makes no difference in the resulting species, whether we offer once nitrates, the next time leucin or a third time betaïn as a source of nitrogen.

This circumstance teaches us not only that the proteids and protoplasms formed from different food, remain in one species the same, but also that the *formation of proteids must commence with relatively simple atomic groups, that are prepared from the most different kinds of substances by oxidation and decomposition.*[2]

Certain combinations are excellent nutrients, like peptones, others poor ones, like valerianic acid, others again do not serve at all as sources of carbon, as oxalates or pyridin salts, and others are poisons, as phenylhydrazin. Small chemical changes may convert a nutritive compound into a poison and the poison again into an indifferent body. These qualities depend upon the chemical constitution and are to some extent merely relative conceptions determined by the degree of concentration. Glucose

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1) The characters of bacteria may however be modified by changing the *conditions of cultivation*; but whether such modifications would lead in course of time to new species, which would be of high importance in connection with the problem of evolution, remains to be investigated.

2) *Pasteur* was the first, who recognised the capability of mould-fungi and bacteria to grow in solutions free from protein compounds, i. e. to form protein and protoplasm from simply constituted combinations, as tartaric acid, ammonia and sulfates. Up to that time (1858) the opinion prevailed that fungi, like animals, could only subsist upon proteids.

can be utilised in higher concentration than sodium acetate, and this in a higher one than acetic ester or phenol, the latter forming in 0,08 % solution a meagre food for a micrococcus,[1] although in higher concentrations a poison for all kinds of bacteria. The more easily a compound is attacked by the cells, the quicker the development of new cells.

As sources of *carbon*: alcohols, acids, ketons, aldehydes, carbohydrates, esters and bases can serve. As sources of *nitrogen*: nitrates, ammonium salts, amido-acids, ureas, guanidins, nitriles, amines, ammonium bases can serve. As sources of *sulfur* may be utilised not only sulfates but also organic sulfur compounds, as sulfons, sulfonic acids and probably also sulfides (methyl sulfide). Our observations in regard to the sources of carbon teach us:—

1) The nutritive quality of acids is enhanced by the entrance of alcoholic hydroxyl-groups; thus lactic acid is superior to propionic acid.

2) The nutritive value of alcohols is increased with the number of the hydroxyl-groups: glycerin is better than propyl alcohol.

3) The presence of aldehyde-or keton-groups increases the nutritive qualities: glucose is better than mannite; acetyl acetic ester is better than acetic ester.[2]

4) The lower alcohols may be used in higher concentration than the higher ones (amyl alcohol).

5) The lower members of the fatty series are more easily assimilated than the higher members; sodium acetate being far superior to sodium valerianate.

6) The unsaturated ring systems are generally not favorable; for instance antipyrin and dimethyloxypyrimidin appear to be entirely unsuitable and while benzoic and salicylic acid are very poor sources of carbon, phenyl acetic acid, containing a CH_2 group, is far better, and chinic acid, containing *a saturated* benzol-ring with 4 CHOH groups is a very good source.

To carry out such experiments, mineral solutions are prepared containing 0,1—0,5% dipotassium phosphate, 0,01—0,05% magnesium sulfate and 0,1—0,2% potassium nitrate or

1) Compare *Nägeli*, Ber. Bayr. Akad. d. Wiss. 1879.

2) I have here operated with 0,1 % solutions. Biol. C. 10, 585.

di-ammonium phosphate.[1] After addition of the organic nutrient to be tested, the liquids are inoculated with bacteria. In those cases, in which the growth of a *specific* bacterium has to be tested, a previous sterilisation is of course necessary. An incipient turbidity, the formation of flocculi or of a thin film and the microscopical examination will very soon indicate that the bacteria have grown and multiplied. Organic bases are best neutralised with phosphoric acid, while acids are best applied as sodium salts.

It is, however, not only of interest to decide, which combinations can serve for nutriment, but also to elucidate the reasons, why often closely related compounds behave far differently from each other, and why certain substances, which are in neutral solution by no means poisonous, cannot be used as food. We find for instance that pyridin, pinacon, dimethyloxypyrimidin, ethylendiamin, amidoacetal, glyoxal, meconic acid, oxalic acid in dilutions of 0,5 % do not support bacterial growth, and acetoxim, diacetonamin, citraconic and maleïc acid permit only with difficulty after a series of weeks a gradual development.[2] These compounds are therefore not well suited for the preparation of those atomic groups that serve for the formation of proteids. Control experiments with addition of 0,2 % peptone indicated, by the rapid development of bacteria, that neither of these substances are poisonous in such a degree as to kill the bacteria if well nourished.

The fact that fumaric acid supports bacterial life so well, that a few days after the infection the liquid swarms with numberless bacteria, while it takes 4 weeks with the isomeric maleïc acid before a slow development, after repeated infection, takes place is of biological interest. Whether here a gradual adaptation took place or only specific germs were developed, remains to be decided. In the case of citraconic acid no development for six weeks was observed; finally, after repeated infections a scanty vegetation set in, consisting of apparently only one kind of bacterium, forming short thick rods often in

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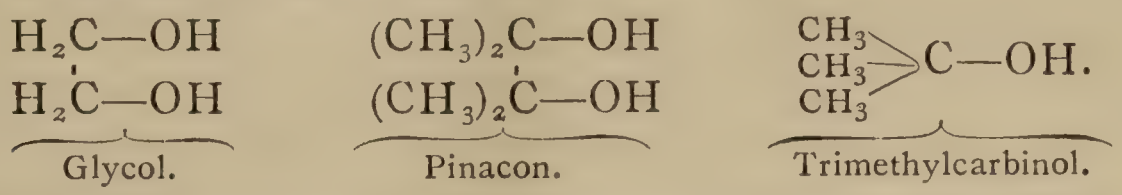
1) Calcium salts are not necessary for the life and development of the lower fungi, Compare *O. Loew*, On the functions of calcium and magnesium salts in plants, Flora 1892.

2) *O. Loew*, Centr. f. Bacteriol. 22, 361

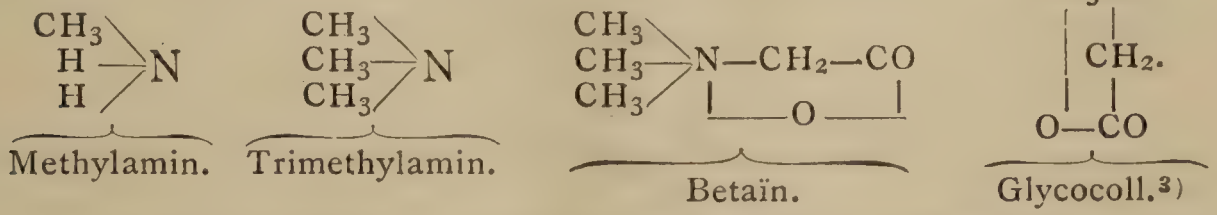
lively motion. At this time fumaric acid in a control solution had been entirely decomposed and the bacterial vegetation formed slimy flocculi at the bottom of the flask.[1]

Of interest is the contrast between the moderate nutritive qualities of aceton and the exceedingly poor results of diacetonamin, further that between glycol and the non-nutritive pinacon, i.e. tetramethylglycol, while trimethylcarbinol forms again a moderately good source:



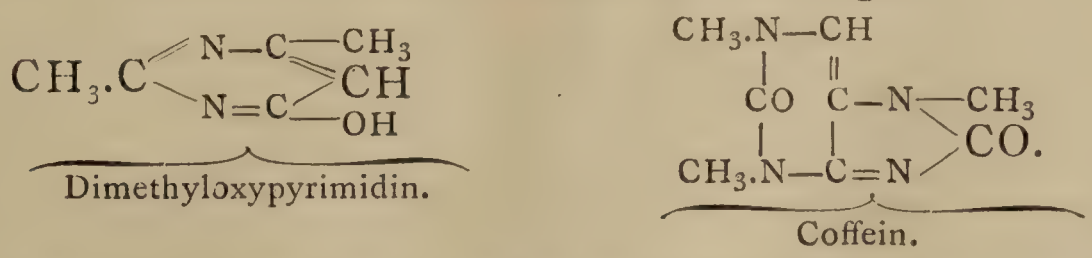
Glycol. Pinacon. Trimethylcarbinol.

While furthermore betaïn forms a better source than glycocoll, we find that trimethylamin is not so favorable as methylamin. If we compare the latter solutions after a strong bacterial turbidity had set in, we have to dilute it at least 5 times with water until the degree of turbidity has reached the weak turbidity of the trimethylamin solution.[2]



Methylamin. Trimethylamin. Betaïn. Glycocoll.[3]

To the nitrogenous compounds which neither serve as a source of carbon nor as a source of nitrogen, belongs dimethyloxypyrimidin[4] in 0,2 % solution, while *coffein* serves not only as a source of carbon, but also as a source of nitrogen.



Dimethyloxypyrimidin. Coffein.

If we compare the monovalent alcohols, from methyl to

1) In this case as in similar ones the principal bacillus developed resembled *Bacillus liquefaciens fluorescens.*

2) Both these bases were applied in 0,5 % solutions neutralised with phosphoric acid, and were infected with *Bacillus methylicus.* *O. Loew*, Centralbl. f. Bacteriol. 12, 465.

3) As regards this formulation of glycocoll, compare *Yoji Sakurai*, Journal of the College of Science, *Vol. 7.*

4) The oxypyrimidins first prepared by *A. Pinner* have a phenol-like character. Deutsch. Chem. Ges. 18. I owe Prof. *Pinner* many thanks for providing me with a number of pyrimidins.

amyl alcohol, we observe that the higher members of the series have noxious qualities. We must apply much higher dilutions to be able to raise a bacterial vegetation. While *methyl alcohol* in 1 % solution, containing 0,1 % K_2HPO_4, 0,1 % $(NH_4)_2HPO_4$ and 0,01 % $MgSO_4$ develops easily bacterial growth, we have to use *amylic alcohol* in dilutions of 0,1 % to make this possible.)[1]

Of considerable interest is the *decrease* in the nutritive qualities of the fatty acids with the *increase* of their molecular weight.[2] If we prepare for instance 0,5 % solutions of sodium acetate and of sodium valarianate and add to each of them 0,2 % $K_1H_2PO_4$, 0,2 % KNO_3 and 0,05 % $MgSO_4$ and infect a set of these solutions with spores of *Penicillium*, with *Saccharomyces Mycoderma* and with bacteria from putrid meat, we observe with acetate of sodium after three days a considerable development, while with the valerianate merely a slight turbidity is visible. After another 3 days a most luxuriant development of *Penicillium*, *Saccharomyces* and of large bacteria takes place in the acetate, while neither *Penicillium* nor *Saccharomyces*, but merely moderate bacterial vegetation consisting of large bacilli forming zoogloœa is observed with the valerianate.

In a like manner it was observed that *Penicillium* did not grow in 0,1 % solution of lecithin,[3] but only bacteria to a moderate extent; this vegetation made the impression of a pure culture, although the infection was made from putrid meat containing various kinds of microbes; probably that solution does not suit for every kind.

The lowest of the fatty acids, formic acid, can, as it seems, only be utilised by one kind of bacterium,[4] evidently a difficulty being encountered here in transforming it into the suitable group for synthetical operations. The next related compound, form-aldehyde, is as such, in the free state, poisonous, but it forms combinations with primary sodium sulfite and with ammonia, which can be utilised as sources of carbon for a bacillus and for a kind of *Dematium*.[4]

1) According to *R. Brown* (Chem. Soc. Journ. 1886) *Bacterium aceti* utilises methyl-, but not amyl alcohol.

2) These observations agree essentially with those of *Stutzer*, *Z.* f. physiol. Chem. 1882.

3) Spores of *Penicillium* were introduced repeatedly during a period of 4 weeks.

4) O. Loew, Centralbl. f. Bacteriol. 12, Nr 14.

5) Ibid. and Botan. Centr. 1890.

I have observed farther that not only methyl alcohol, but also methylal and methyl sulfuric acid[1] may in proper dilution (0,2-0,3%) be used as food by bacteria, i. e. as material for building up protein and protoplasm. *The group then used for this purpose must contain only one atom of carbon and cannot be any thing else but form-aldehyde, the same substance that forms by condensation various kinds of sugar.* Neither acetic, glycolic, nor amidoacetic acid can be utilised as such, but they may lead by oxidation to one compound which can be utilised, viz. to *form-aldehyde*; no other unsaturated atomic group could result, suitable for synthesis. This oxidation[2] in the cells may be expressed by the following equation in the case of acetic acid:

$$CH_3.COOH + O_2 = CH_2O + CO_2 + H_2O$$

If this conclusion is correct, then we can understand, why substances containing the group CHOH are very favorable for nutriment and why the useful qualities increase with the number of these groups (the polyvalent alcohols, the polyvalent acids). We can understand furthermore, why such substances are capable of nourishing certain bacteria endowed with *fermentative properties, even in the absence of air,* while compounds without this group can be used as food only in the presence of air, oxidation being then necessary to produce this CHOH-group or the isomeric formic aldehyde. But can that conclusion be admitted if formic aldehyde is a poison? No doubt this seems an objection of weight, but if we consider how easily the formic aldehyde is changed under condensating influences and how indifferent certain compounds of this aldehyde are, the objection no longer appears so serious; we must only adopt the view that the formic aldehyde undergoes rapid transformations and that no molecule formed remains unchanged for a second.[3]

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1) In this case an alkaline reaction is necessary for obvious reasons.

2) Oxidation by respiration has here evidently not only the *physical* rôle of yielding energy, but also a direct *chemical* function in preparing the suitable group for synthesis.

3) Compare *O. Loew*, Ber. d. Deutsch. Chem. Ges. 22, 484. Synthetical processes require substances of a certain lability; very reactive substances however are more or less poisonous. The objection of some botanists to the view of the formation of sugar from form-aldehyde in plants is not more tenable since *Bokorny* has shown that the combination of form-aldehyde with primary sodium sulfite can be utilised by plants for the production of starch. Landw. Jahrb. 1892.

We have mentioned above that a certain kind of bacillus[1] can utilise formic acid (as sodium salt) as a source of carbon which is of special interest. Here the first step is most probably a transformation into glyoxylic acid and a subsequent splitting of the latter into form-aldehyde and carbon dioxide,[2] as may be expresed by the following equations;

$$2\ H.COOH = O{:}CH.COOH + H_2O$$
$$O{:}CH.COOH = CH_2O + CO_2$$

The necessary energy is evidently furnished here by the oxidation of a certain portion of the sodium formiate into sodium carbonate, clearly indicated by the gradual increase of the alkaline reaction. The more energy, however, a compound yields in being utilised for protein-formation, the better the effect must be; we can therefore understand, why methyl alcohol is a better source of carbon than form-aldehyde (in the shape of $CH_2OH.SO_3Na$) or formic acid. Methyl alcohol yields by its transformation into form-aldehyde an amount of energy, that form-aldehyde cannot furnish; the necessary energy must be gained here by oxidation of such molecules to carbon dioxide and water.

We understand now why oxalic acid, parabanic acid, urea or guanidin cannot be used as sources of carbon; this is because these compounds cannot be transformed by bacteria into form-aldehyde. If pyridin, pinacon or dimethyl-oxypyrimidin will not serve, it is very probably on account of the considerable resistance they offer to oxidising influences. If amidoacetal, glyoxal, or ethylendiamin are incapable of yielding a bacterial vegetation, and diacetonamin and acetoxim apparently do so only with great difficulties, we might suspect a certain degree of poisonous character, that cannot make its appearance in presence of a nutrient like peptone.[3] But for the difference of physiological value between the stereo-isomeric maleïc and fumaric acid, we have at present no explanation.

As a general rule we find that compounds, containing the

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1) This bacillus, which I named *Bacillus methylicus*, can also utilise the combination of form-aldehyde with primary sodium sulfite, $CH_2OH.SO_3Na$ oxymethylsulfonate of sodium in 0,5°/₀ solution.

2) Compare *Koenigs*, Ber. Deutsch. Chem. Ges. 25, 801.

3) Some of the combinations of this group might perhaps be utilised in much higher dilutions than tested (0,5°/₀).

groups CH_3, CH_2, CHOH, CH_2OH can be used as sources of carbon, if they neither act poisonously nor offer too much resistance to the attacks of bacteria. If the atomic group CH : CH is utilised, as in the case of fumaric acid, we might easily explain this by the conversion into $CH_2.CH_2$ OH, a molecule of water being taken up. In the following table are enumerated a number of compounds that form very good sources(I), moderatly good sources(II), very poor sources (III) and such, as far as observations reach, cannot be utilised as sources of carbon(IV).

I	II	III	IV
Glycerin	Methyl alcohol	Phenol	Pinacon
Mannite	Aethylenglycol	Acetoxim	Sulfonal
Sugars	Aceton	Diacetonamin	Amidoacetal
Lactic acid	Acetic acid	Valerianic acid	Oxalic acid
Succinic ,,	Fumaric ,,	Maleïc ,,	Meconic ,,
Tartaric ,,	Pyruvic ,,	Citraconic ,,	Picric ,,
Citric ,,	Laevulinic ,,	Benzoic ,,	Antipyrin
Betaïn	Glycocoll	Lecithin	Dimethyl-oxypyrimidin
Alanin	Methylamin	Trimethylamin	Aethylendiamin
Leucin	Cholin	Strychnin	Pyridin
Asparagin	Allantoin	Hexamethylenamin	Urea
Glutamin	Coffein	Amidobenzoic acid	Parabanic acid
Kreatin[1]	Methyl cyanide	Glyoxylic acid	Guanidin

A most remarkable phenomenon in regard to bacterial development (therefore also to the formation of protein) was first observed by *F. Hüppe*,[2] and later confirmed by *Munro* and by *Winogradzky*, that the nitrifying bacteria of the soil may develop in solutions destitute of organic matter, and may utilise ammonium carbonate. *Hüppe* assumed here a decomposition of water,

1) *Th. Bokorny* and myself have made a series of experiments to nourish also *algae* with organic matters, and observed a much more favorable result with kreatin and hydantoin than with leucin or urethan. Recently *Th. Bokorny* extended these investigations to a larger number of combinations, showing that algae may well *utilise* organic matters, although they do not *require* them for supporting their life. (Chemikerzeitg. Jan. 1894).

2) *Hüppe*, Biol. Centralbl. 7, 702.

whose oxygen would produce the nitrification in acting upon the ammonia, while the hydrogen would act reducing upon the carbonic acid of this salt, producing thus form-aldehyde, or carbohydrates. The process, however, would appear simpler if a part of the hydrogen of the ammonia could be employed for this reduction. I tried to explain this process by the following equations[1]:

$$2NH_3+2O_2=2NO_2H+4H,$$
$$CO_2+4H = CH_2O+H_2O,$$
$$6CH_2O = C_6H_{12}O_6.$$

This production of organic matter from inorganic without the aid of the chlorophyll apparatus is certainly most extraordinary.

Some additional remarks may be made on the nutrition of mould-fungi (*Penicillium, Aspergillus, Mucor*). Substances supporting the life of aërobic bacteria generally also serve as food for mould-fungi; however there exist exceptions: methylamin, methyl alcohol or sodium valerianate are better utilised by bacteria, glyoxal better by mould-fungi. Neutral reaction is best suited for most kinds of fungi, in alkaline liquids however bacteria thrive better than mould-fungi, while in an acid one the contrary is observed (with certain exceptions[2]). In certain solutions the development of bacteria will prevent the development of mould-fungi, in other solutions again both kinds of fungi may thrive at the same time. I infected for instance a solution containing potassium sodium tartrate 1%, di-potassium phosphate and diammonium sulfate 0,1% of each, and magnesium sulfate 0,05%, with bacteria of putrid meat and with spores of *Penicillium glaucum*, simultaneously, but only the bacteria developed although I rendered after 2 weeks the solution slightly acid with monopotassium phosphate and infected once more with *Penicillium*-spores. On the other hand when glucose was employed instead

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1) *O. Loew*, Ibid. 10, 758 and Centralbl. f. Bacteriol. 9, Nr. 20. *Warington* expressed recently the same idea (Chem. News 68. 175) and gave the following equation:

$$(NH_4)_2CO_3+O=NH_4.\,NO_2+CH_2O+H_2O.$$

2) While *Bacterium aceti* thrives well in a solution containing several per cent acetic acid, cases may also be observed, where in an alkaline liquid bacteria cannot thrive but only mould-fungi.

of the tartrate, both kinds of fungi developed well simultaneously.

It is of interest to compare the amount of mould-fungus with the quantity of the compounds used for development; considerable differences are here observed. While isobutylic alcohol yields only 9—10 % fungoid matter, asparagin yields nearly 22 %; tartaric acid yields less than succinic, tannin less than sugar. Albumin in 1 % solution will yield about 23 % of its weight, while a mixture of albumin (1 %,) and cane-sugar (2 %) nearly 33 %.

To those compounds which cannot be utilised by mould-fungi belong maleïc acid,[1] citraconic, mesaconic, dibenzylmalonic and diethylsuccinic acid. Benzyl-succinic, disubstituted glutaric acid and oxyisobutylic acid are very poor sources, while malonic, succinic, monomethylsuccinic and monoethylsuccinic acids are well utilised.[2]

But it is not only in regard to the *sources of carbon* that a great variety exists; this holds good also in regard to the *sources of nitrogen*. Of the great number of the latter compounds we mention as examples: nitrates, ammonium salts, glycocoll, asparagin, kreatin, allantoin, methylamin, acetamid, methylcyanide, betaïn, strychnin. Nitrites are in a certain concentration less favorable than nitrates and are in *acid* solutions poisonous. Ferrocyanide of potassium is but a poor source of nitrogen while hydroxylamin and diamid cannot be utilised at all, being strong poisons, and azoimid only in high dilutions.[3] For the same reasons, as explained above for the sources of carbon, the nitrogen compounds used must be converted first into the one and the same atomic group, before the synthetical work can begin; this group is evidently ammonia which, in form of salts, is not only very favorable for mould-fungi and bacteria, but also the simplest nitrogen compound that can directly be utilised.[4] If organic nitrogen compounds are used as sources

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1) *E. Buchner* B. d. Deutsch. Chem. Ges. 1892 p. 1163.

2) *B. Meyer*, Ibid. 1891 p. 1071.

3) *O. Loew*, Biol. Centralbl. 10, 588 and Ber. Deutsch. Chem. Ges. Vol. 24, p. 2947. Certain fungi, as *Saccharomyces Mycoderma* prefer ammonia as source of nitrogen to amido-acids and peptone (*Beyerinck*). The common beer-yeast however can at *low* temperature make better use of the latter than of the former, and cannot utilise nitrates (*A. Mayer*). *Laurent* has shown that these are converted here into the poisonous nitrites.

4) Nitrates have to be reduced first.

of nitrogen, the latter has to be split off in shape of ammonia, before the protein formation can begin. This can be accomplished in many cases by simple splitting (acetamid, kreatin, urea, etc.), in other cases by oxidation, as with leucin, methylamin, betaïn. Chinin and strychnin are poor sources of nitrogen, being attacked by fungi with difficulty, and antipyprin and dimethyl-oxypyrimidin offer so much resistance, that their nitrogen cannot at all be utilised.

The *anaërobic* microbes may by *reducing* influences transform nitrogen of certain compounds into ammonia, while the *aërobic* employ *oxidation :*

1) $H_2N.CH_2.COOH + 2H = NH_3 + CH_3.COOH$,

2) $H_2N.CH_2.COOH + 3O = NH_3 + 2CO_2 + H_2O$.

A very remarkable case is the assimilation of *free nitrogen* by certain bacteria of the soil as was asserted years ago by *Berthelot*[1] and recently confirmed by *Winogradzki*. The free nitrogen is here probably first converted into ammonium nitrite,[2] and the nitrous acid then also rapidly reduced to ammonia.

The proteids of mould-fungi and of yeasts[3] contain, like the other proteids, sulfur which can partially be split off by diluted alkaline ley in form of sulfide; the sulfur must therefore be in a very loose form of combination, very probably present as—SH in the proteins. Sulfates have to be reduced therefore to sulfuretted hydrogen, before the sulfur can be assimilated, and organic sulfur compounds have to be split before reduction and assimilation take place. My experiments with sulfonal $(CH_3)_2 : C : SO_2(C_2H_5)_2$ have shown that this substance serves well as a source of sulfur for mould-fungi and yeasts, in the presence of a good source of carbon; but in the absence of such a source, sulfonal cannot be used, although it contains the methyl and ethyl group, i.e. otherwise good sources of carbon; the fungi refuse to

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1) Compt. rend. 101.—Also *Gautier* and *Drouin*, Ibid, 106.

2) About this transformation with the aid of platinum black, see *O. Loew*, Ber. Deutsch. Chem. Ges. 23, 1444.

3) *Nencki* found in 2 cases no sulfur in the proteids of *bacteria*.

Mitscherlich found in *yeast* 0,6 % sulfur. If yeast be treated with a diluted solution of caustic potash, a considerable amount of potassium sulfide is formed.

grow in solutions containing as sole organic matter sulfonal (0,2 %).

Of course sulfuretted hydrogen is only produced in the necessary amount for immediate need, as accumulation would be noxious; experiments intented to prove that H_2S as such can be assimilated, meet for obvious reasons with some difficulties.

Our considerations, therefore, lead logically to the conclusion, that the atomic groups, serving for the formation of proteins are three very reactive combinations:

Form-aldehyde, *ammonia* and *sulfuretted hydrogen*.

II. The Formation of Proteids in Chlorophyll-bearing Plants.

As chlorophyll-bearing plants produce by assimilation carbohydrates, it is natural that such well suited compounds should form here also the main source of carbon for the synthesis of proteids.[1] Nitrates or ammonium salts furnish the nitrogen, sulfates the sulfur. The chemical behaviour of the protein compounds indicates very clearly, that neither the nitrogen nor the sulfur is connected with oxygen, but only with carbon and hydrogen. It follows, therefore, that *reduction* of the nitrates and sulfates has to take place, here as well as in the case with the lower fungi. If all conditions are otherwise favorable, then the synthetical work proceeds so rapidly that the intermediate steps cannot be directly traced. From numerous observations, however, the conclusion appears justified that it is *asparagin* to which an important rôle must be attributed in this connection, a conclusion which at first was arrived by the ingenious *Th. Hartig*. *Borodin*, *Pfeffer* and *Kellner* declared asparagin to be the form, in which the transportation of albuminous bodies takes place. The most important investigations, however, we owe to *E. Schulze* and his school.

Asparagin has been found *normally* in many plants, but under *special* conditions in still more cases. The root of *Althæa* contains

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1) It can hardly be doubted, that all such substances as are capable of being converted into *starch*, as glycerine (*Arthur Meyer*, *Laurent*) or glycol or methyl alcohol (*Th. Bokorny*) also serve as sources of carbon for the formation of protein compounds Also the combination of formic aldehyde with primary sodium sulfite may be used under certain circumstances (*Th Bokorny*).

2%, that of *Glycirrhiza* 0,8% (*Plisson*), that of *Scorzonera* 0,6% (*Gorup*), Potatoes 3% (*E. Schulze*). It was found in the root of *Symphytum*, in *Lactuca*, in the shoots of *Asparagus*, of *Humulus*, and of *Bambusa* (*Kozai*) [1] in the leaves of *Atropa*[2] and in the leaf-buds of *Ulmus effusa*, *Spiraea sorbifolia*, *Sp.opulifolia*, *Populus tremula*, *Quercus pedunculata*, *Lonicera tatarica*, *Tilia parvifolia*, *Alnus* (*Borodin*). Buds of *Betula* and of different conifers show normally no asparagin, but soon after the cut twigs are *placed in water*. *Borodin* found that, under this condition, also flowers, stems and parts of fruits can form asparagin,[3] and *E. Schulze* found the same with twigs of *Fagus sylvatica*, *Populus nigra*, *Vitis vinifera*, *Acer*, *Platanus*; *Betula* formed after 10 days 2,0% asparagin. *Kisser* demonstrated that this production of asparagin is connectedwith a *decrease of protein-matter*.[4]

Kellner observed, that in young grass often more than 30% of the nitrogen is present in form of amido-compounds, especially as asparagin and glutamin.[5] According to *Emmerling* young leaves of *Vicia* are richer in asparagin than old ones, and shoots, buds and newly formed fruits contain sometimes considerable quantities.[6] Fresh stems of *Medicago sativa* contain 7 times as much asparagin as the fresh leaves (0,05%). The inner bark (liber) of *Platanus* contains asparagin, but not that of *Quercus*, *Tilia*, or *Fraxinus* (*E. Schulze*).

Boussingault was the first, who found asparagin as a constant product in plants that are deprived of light.[7] Oats, cultivated in pots, if deprived of light for 7 days, yielded 1,67% asparagin of the dry matter, the nitrogen of which corresponds to 60% of the nitrogen of the decomposed protein compounds. Red clover produced after 8 days in the dark 14 times as much asparagin as under normal conditions.[8] The absence of light brings on a gradual decrease of carbohydrates, respiration going on and

1) Bulletin Vol. I, No. 7 of the Agricultural Dep. of the Imp. University of Tokio.

2) *Husemann* and *Hilger*, Pflanzenchemie Vol. I.

3) Botan. Zeitg. 1878, p. 208.

4) Landw. Jahrb. 1888, p. 702.

5) Ibid. 1879, p, 243.

6) Landw. Versuchsstat. 24, 113.

7) Compt. rend. 58, 881 a. 917.

8) *E. Schulze*, Landw. Versuchsstat. 36. According to *O. Müller* asparagin is also formed if the growing parts alone are kept deprived of light (Ibid. 33, 310).

new production being stopped. There appears in many cases a close connection existing between the decrease of carbohydrates and an incipient decomposition of protein compounds with production of asparagin. Thus *Monteverde* has observed, that twigs of *Syringa vulgaris*, kept in the dark for 15 days, produce a great deal of asparagin; but if the twigs instead of being placed in water are kept in a 6-8 per cent solution of glucose or sucrose, no trace of asparagin is formed, but much starch and mannite.[1] Other investigations have elucidated the interesting fact, that the amount of asparagin formed in the germination process *increases* if the reserve carbohydrates *decrease* in quantity. The proportion of protein to carbohyrates is

in wheat-kernels = 1 : 5
in peas = 1 : 2
in beans = 1 : 1,8
in gourd-seeds = 1 : 1,5
in soya-beans = 1 : 0,9
in lupin-seeds = 1 : 0,5.

Germinating peas contain 2,4-2,6% asparagin of the dry substance (*Sachsse aud Kormann*). In the shoots of Cucurbita (gourd) there are 40% of the nitrogen of the decomposed proteids present in form of asparagin and glutamin; generally more of the latter than of the former (*E. Schulze*).[2] In germinating soya-beans half of the nitrogen of the decomposed protein is found again as asparagin. In the *lupin-seeds*, however, the greatest amount of asparagin is found; the *percentage of nitrogen* of the decomposed protein compounds (mostly conglutin), which is present in form of *asparagin*, is with germs 4 days old = 45,7

7 ,, ,, = 56,7
12 ,, ,, = 63,5
24 ,, ,, = 73,4.

In the axial parts (root and stem) of lupin-shoots the asparagin amounts to 30% of the dry matter, in the cotyledons to 8-9%.[3] The great amount of asparagin in the stem of a

1) Botan. Centralbl. 1891, 380. Also an observation of *Church* (Journ. Chem. Soc. 49, 840) may be mentioned here, according to which leaves suffering from albinism contain 2,4 times as much nitrogen in form of amido-compounds (which?) as green leaves of the same trees (*Elaeagnus pungens*).

2) Landw. Jahrb. Vol. 12 p. 916.

3) *E. Schulze*, Landw. Jahrb. 17; Journ. f. prakt. Chem. 1883.

germinating lupin can be well demonstrated by treating a thin cut through the stem with alcohol under the microscope, *a large number of asparagin crystals* will soon be observed.

There exist, however, cases in which a considerable amount of asparagin is found in *presence* of a large amount of carbohydrates, as in the shoots of *Cannabis sativa* and of *Helianthus* annuus. In the latter case were found 4% asparagin and 14,7% sucrose.[1] *Scheibler* found in the sugar-beet considerable quantities of asparagin; more frequently, however, the next higher homologue, glutamin, in larger quantities than the former.[2] In the juice of potatoes freed from albumen, more than 46% of the nitrogen is present in form of asparagin, although there is not only a great amount of starch, but also some reducing sugar present (*E. Schulze*). In *Trifolium, Medicago* and *Vicia* is found 1-2% asparagin in presence of 1,5-2% of glucose (*E. Schulze*).

These numerous facts doubtless reveal a certain physiological significance of asparagin. Let us now take a glance at the other nitrogenous compounds formed by decomposition of protein bodies. Small quantities of leucin and tyrosin are encountered in potatoes, but whether they are formed *in loco* or had been transported from the leaves to the bulbs is not decided; they are however probably decomposition products of albuminous compounds. The same amido-acids were found by *E. Schulze*[3] in small quantities in germinating seeds of *Cucurbita*. *Kozai* found tyrosin in bamboo-shoots. Tyrosin was found only in traces in lupin-shoots, leucin however not at all. Phenyl-amido-propionicacid and amidovalerianic acid occur here in larger quantities. Also an interesting new base, *arginin*, $C_6H_{14}N_4O_2$ was discovered by *E. Schulze* and *Steiger*[4] in the cotyledons of germinating lupin-seeds. These authors proved also that this base is derived from the decomposition of proteids; it amounted to 7,8% of the dry substance of the cotyledons and was not found in the axial organs. It is probably derived from

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1) *Frankfurt*, Landw. Versuch-Stat. 43, 143.

2) Ber. d. Deutsch. Chem. Ges. 1869. *Schulze* and *Urich*, Landw. Versuchs-Stat, 20, 193.

3) Landw. Jahrb. Vol. 9; Vol. 12; Vol. 14.

4) Zeitsch. f. physiol. Chem. Vol. 11 p. 43. Ber. Deutsch. Chem. Ges. Vol. 19, p. 1177.

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the same atomic group, that leads by the decomposition of proteids with hydrochloric acid to lysin $C_6H_{14}N_2O_2$ and lysatin $C_6H_{13}N_3O_2$, which were discovered by *Drechsel*. Arginin is contained also in the Cucurbita-shoots but only in very small quantities; also in the soya-shoots it appears to be present.[1)]

Another nitrogenous substance, not found hitherto in plants, was discovered by *E. Schulze* and *I. Barbieri* in the young leaves of *Platanus*, allantoin.[2)]

Also the bark of *Aesculus Hypocastanum* and leaves of *Acer pseudo-platanus* and *Acer campestre* contain small quantities.[3)] While the shoots of *Platanus*-buds contain as much as 1% allantoin, it could not be discovered in many other plants (*Vicia*, *Trifolium*, *Betula*, *Fagus*, *Tilia*, *Populus*, *Vitis vinifera*, shoots of *Cucurbita* and *Lupinus*.)[4)]

Urea as such has not yet been found in plants, but the closely related guanidin was discovered by *E. Schulze* in shoots of *Vicia sativa*.[5)] Still another base was found by *E. Schulze* and *E. Bosshard* in young Vicia and Trifolium, in cotyledons of germinating *Cucurbita* and in ergot (*Claviceps purpurea*); it was called *vernin*, corresponds to the formula $C_{16}H_{20}N_8O_8+3H_2O$ and yields by decomposition with hydrochloric acid *guanin*.[6)] Later the same substance was found by *E. Schulze* and *A. v. Planta* also in the pollen of *Corylus avellana* and of *Pinus sylvestris*.[7)] Whether this base results from decomposition of protein has not been proved positively, but as to the other products mentioned, there cannot exist any doubt. *Gorup-Besanez*, who first discovered leucin in plants (shoots of *Vicia*), was also the first to demonstrate

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1) *E. Schulze*, Zeitsch. f. physiol. Chem. 11, 43 and Journ. f. prakt. Chem. 32, 433.

2) Ber. d. Deutsch. Chem. Ges. 13, 1602. Allantoin, $C_4H_6N_4O_3$, occurs in the animal body and is a derivative of urea, a diureïd of glyoxylic acid. Also arginin is a derivative of urea (*Schulze*) like lysatin (*Drechsel*).

3) Zeitschr. f. physiol. Chem. 9, 420. *Richardson* and *Crampton* found small quantities of allantoin in germinating wheat (Ber. Deutsch. Chem. Ges. 19).

4) All these plants were kept for some time in the dark to bring on a decomposition of protein (*E. Schulze*).

5) Ber. d. Deutsch. Chem. Ges. 25, 658. 3 kilo of dry shoots yielded only 1g. of nitrate of guanidin.

6) Zeitschr. f. physiol. Chem. 10, 80.

7) Ibid. 10, 326. From 1300 g. of Corylus-pollen about 1g. of vernin was obtained.

the presence of a digesting ferment, resembling trypsin, in plants, to which he ascribed the production of amido-acids from proteids.[1)]

If we compare now the quantities of the different amido-acids and bases with that of asparagin we find generally the latter present in larger quantity, although the decomposition of proteids by enzymes or by mineral acids yields only relatively small quantities of aspartic acid (which in the plant-cells might easily be transformed into asparagin). While 100 parts of conglutin (the principal reserve protein in lupins) yield upon decomposition with hydrochloric acid 6 parts of glutaminic acid, 1,5 parts of aspartic acid, 10 parts of leucin and 2 parts of tyrosin, we find in lupin-shoots 12 days old, the asparagin in dominating quantities, amounting to almost 30 per cent of the dry substance, while tyrosin was found only in traces and glutamin could not be found with certainty. Instead of leucin the next lower homologue (perhaps produced from the former by oxidation), was found.[2)] The germinating seeds of *Cucurbita* contain only a very small amount of leucin, but 1,75 per cent of glutamin and 0,06 per cent of asparagin; tyrosin amounted here to 0,25 per cent.

According to *Ritthausen* gluten-casein yields on decomposition with hydrochloric acid 0,3 % aspartic and 5,3 % glutaminic acid; legumin yields 3,5 % of the former and 1,5 % of the latter (only mucedin yields larger quantities of glutaminic acid, viz. 25 %). Still we find in plants generally asparagin as the main product,[3)] the other amido-compounds disappearing rapidly again and being found only in relatively small quantities. *Schulze* supposed that the decomposition of protein in plants would yield the same products and in the same quantities as the decomposition by trypsin or by acids, but that the regeneration of proteids would proceed more easily from the other amido-compounds than from aspartic acid, hence the latter—transformed into asparagin—must accumulate.[4)] This is,

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1) Ber. Deutsch. Chem. Ges. Vol. 7 and 10.

2) *E. Schulze* and *Barbieri*, Landw. Jahrb. 1880, p. 18. Most proteids yield by decomposition with acids more than 20 per cent leucin.

3) In certain cases mentioned above, asparagin is found replaced by its next homologue, glutamin. This might he gradually transformed into the former in the plant-cells or like asparagin serve in the regeneration of certain proteids.

4) Other views upon this subject were discussed by *E. Schulze* in Landw. Jahrb. Vol. 17 and 21.—He showed that they are either incorrect or imperfect.

however, an erroneous assumption, for experiments with bacteria and with mould-fungi have convinced us that asparagin and aspartic acid form most excellent nutrients, being evidently very favorable sources of carbon and nitrogen for the formation of protein, for the growth of protoplasm, i. e. multiplication of cells. These combinations are far superior to tyrosin or phenyl-amidopropionic acid, which would, moreover, have to undergo a thorough chemical change before the formation of proteids could commence.

An observation of *E. Schulze* is, in this connection, of fundamental importance. He found that the quantity of amido-acids formed during the first period of germination is continually *decreasing*, whilst the amount of asparagin is *increasing ;* he showed furthermore, that the proportion of asparagin is much greater in the axial organs than in the cotyledons, as is seen from the following table:

Lupin shoots.	The protein-free extract contains nitrogen in form of:			
	In the cotyledons.		In the axial parts.	
	Asparagin.	Other amido-compounds.	Asparagin.	Other amido-compounds.
6 days old	20,5	79,5	68,8	31,2
12 days old	26,2	73,8	78,1	21,1

100 parts of lupin-shoots containing 16,8 parts of asparagin yielded, after 3 weeks vegetation in diffused daylight, 151 parts of green plants with 23,9 parts of asparagin.[1] The primary amido-products disappear first, their carbon serves partially to support respiration, while another part of their carbon together with their nitrogen is found now in form of asparagin, and this again disappears finally with the increase of available glucose, formed by the function of the chlorophyll. The asparagin evidently indicates the manner of the protein formation, it is

1) Landw. Jahrb. 9, 41. The sulfur of the decomposed protein is converted into sulfates, which later serve afterwards again in reconstruction of the proteids (*E. Schulze;* Tamann).

a transitory product, found when the conditions of finishing the process of protein-synthesis are not complete. To these conclusions we are led by the circumstances under which asparagin appears in shoots, and disappears again.

When sugar participates in the formation of proteids from *asparagin*, it evidently *yields* the *carbon* to make up the deficiency; this function, however, would not be required if *aspartic acid* were used; the proportion of the number of atoms of

N : C is in albumen	1 : 4
in aspartic acid	1 : 4
in asparagin	1 : 2

(in tyrosin 1 : 9, in leucin 1 : 6).

Several considerations (see Chapt. VIII) make it highly probable, that the formation of protein compounds consists in a rapidly proceeding condensation process, in a certain degree analogous to the formation of sugars from formic aldehyde.[1] To render, however, such a process possible, asparagin would best be converted into the di-aldehyde of aspartic acid, a reducing process whereby glucose very probably would have to furnish the necessary hydrogen:

$$\underbrace{\begin{array}{l}CONH_2\\|\\CH_2\\|\\CH.NH_2\\|\\COOH\end{array}}_{\text{Asparagin.}} + 4H = \underbrace{\begin{array}{l}COH\\|\\CH_2\\|\\CH.NH_2\\|\\COH\end{array}}_{\text{Aspartic aldehyde.}} + NH_3 + H_2O.$$

The conditions in the living cells would not permit for a moment these products of reductions in a free state, and in presence of glucose the ammonia set free would be transformed at once into organic combinations, most probably into another molecule of aspartic aldehyde; thus asparagin and glucose would yield directly 2 mol. of this aldehyde, which may be expressed by the following equation:

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1) I have been the first to show that formic aldehyde will by condensation yield *true sugars*, and the first to prove beyond a doubt, that such a synthetical sugar is capable of alcoholic fermentation. No sophistry can disprove these facts. Compare Journ. f. prakt. Chem. 33, 332; Ber. d. Deutsch. Chem. Ges. 20, 142 and 3042; Ibid. 22, 477 and 481; Landw. Versuchstat. 41, 132.

$$\underbrace{C_4H_8N_2O_3}_{\text{Asparagin.}}+C_6H_{12}O_6+2O=2\underbrace{C_4H_7NO_2}_{\text{Aspartic aldehyde.}}+2CO_2+3H_2O.$$

The condensation process, however, leading from this highly labil[1]—and still hypothetical—amido-aldehyde to the active albumen must be accompanied by a reducing process and by the entrance of sulfur. We may express this process by the following equations:

$$\underbrace{3C_4H_7NO_2}_{\text{Aspartic aldehyde}} = \underbrace{C_{12}H_{17}N_3O_4}_{\text{Intermediate product}}+2H_2O;$$

$$6C_{12}H_{17}N_3O_4+12H+H_2S=\underbrace{C_{72}H_{112}N_{18}SO_{22}}_{\textit{Lieberkühn's}\text{ albumin-formula.}}+2H_2O.$$

For the reduction indicated in the latter equation the presence of glucose would be again required.[2] If we now make the assumption that under certain chemical conditions the aldehyde groups are prevented from acting during the condensation process upon the amido-groups (which is to be expected under normal conditions) and that the hydrogen serving for reduction would transform 12 aldehyde groups into secondary alcoholic groups (CH OH), causing thereby a pinakon-like linking—then we should have in the final product—the active albumen—a substance of extraordinary lability, containing 12 aldehyde- and 18 amido-groups in one molecule, and changing easily into another product with the loss of its aldehydic character—the passive albumen.

The accumulation of asparagin is evidently connected with the gradual disappearance of the amido-products, directly resulting from a decomposition of protein. This fact finds its most natural explanation if we recall the conclusions, to which we were led by the study of the nourishment of the lower fungi (see page 49). We had logically concluded that if different compounds serve to yield the same protein, then they must be transformed first into *one and the same atomic group* from which the protein formation can start. We had seen that this group cannot

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1) Amido-aldehydes are as we have explained in Chapt. III exceedingly unstable compounds, which may play important physiological rôles in more than one respect. *Wolffenstein* observed recently an easy transformation of amido-valeraldehyde into piperidin, and holds it highly probable that amido-aldehydes form the connecting links between the fatty series and the alkaloids in plants.

2) On glucose as a reducing agent in neutral or even acid solutions, see Chapt. VI.

be any other one than form-aldehyde. If the fungi utilise once leucin, another time tyrosin, a third time tartrate of ammonia, then an oxidation must set in to reach the common starting point.[1] And this must hold good also for the higher plants, for it can hardly be assumed that the mode of protein formation is here entirely different. If for the purposes of transportation and transformation (conglutin into active albumin and living protoplasm), in lupin-shoots, the reserve protein is first dissolved, and split into a series of amido-products (leucin, admido-valerianic acid, tyrosin, phenyl amido-propionic acid, arginin, etc.) by an enzyme, then in all probability and logically all those different products must be transformed into the common starting group: formic aldehyde, and their nitrogen be liberated as ammonia; thus the decomposition of leucin by oxidation might be expressed by the following equation:

$$C_6H_{13}NO_2+7O=2CO_2+H_2O+4CH_2O+NH_3.$$

Form-aldehyde and ammonia, however, act noxiously and do not remain as such for a second; *aspartic aldehyde* being formed.[2] This product however does neither remain unchanged, it will yield either *directly active albumen* when all conditions are fulfilled, or it will be stored up as *asparagin* if not all conditions are united for protein production.[3]

The asparagin in plants has two sources; it may either be formed *directly* from glucose, ammonia (or nitrates) and sulfates, or it may be a transitory product between protein-decomposition and reconstruction from the fragments. In both cases the *immediate* processes connected with the formation of asparagin have the greatest resemblance or are even identical,—although the original materials are far different.

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1) Compare Chapt. III and Chapt. VIII of this essay. I developed the outlines of this hypothesis first in *Püflg. Arch.* 1880.

2) The still hypothetical formation of aspartic aldehyde, from formic aldehyde and ammonia may be expressed by $4CH_2O+NH_3=C_4H_7NO_2+2H_2O$

3) Closely related to asparagin is succinic acid, found not only often in the higher plants, but also encountered in fungi. I found this acid also in algae (Spirogyra), in hay of meadows, in the cambial sap of conifers and in the common yeast (Ber. Bayr. Akad. d. Wiss. 1878; Journ. f. prakt. Chem. 36). I observed also this acid as a product of oxidation of albumen by potassium permanganate (Journ. prakt. Chem. 31, 152).

To effect the synthesis of proteids,—especially in the last phases—a certain amount of energy is required. This energy is procured by respiration. Respiration, however, also brings on the *partial oxidations* necessary for transforming glucose into asparagin or aspartic aldehyde. Where respiration is impeded, the protein production will be retarded. It is, therefore, not surprising that in the interior of potatoes and beets, asparagin is found in company with starch and reducing sugar and that the *stem* of plants contains more asparagin than the *leaves*, as *Schulze* has found. The stalks of *Medicago sativa* contain 7 times as much asparagin as the leaves. Stems and cotyledons of young lupin-plants cultivated first in the dark and afterwards 4 weeks in daylight, contained 18,4% asparagin, the young *leaves*, however, only 6%. The structure of the leaves and their numerous stomata certainly secure a much more energetic respiration than the structure of stems, roots and bulbs. As respiration is best supported by carbohydrates, it is clear that glucose plays a still more important rôle in protein formation: it yields chemical energy, and as the *leaves* produce by assimilation of carbonic acid a large amount of glucose, it follows that the *leaves* must be the most favorable organs of the plants for the production of proteids. The sun-rays are thus indirectly a great supporter of protein-formation. *Directly*, however, no such influence is required, as I have shown in experimenting with mould-fungi grown in the dark and in diffused day-light; not only was the development of the fungus just as energetic in the dark as in the light but in some cases it even exceeded the latter. Here glucose and glycerin served as organic nutrients.[1)]

But while *access* of air is indispensable for the production of asparagin and proteids, such is not the case for the action of the enzymes in peptonising and decomposing the reserve proteids in the germinating seeds. *Palladin* has proved that shoots,—which remain alive in the *absence* of air for 24 hours—cease to produce asparagin under this condition,[2)] while the production of amido-acids by enzyme is still going on.

Glucose is in more than one respect highly important for

1) *O. Loew*, Biol. Centralbl. 10, 584.

2) Ber. d. Deutsch. Botan. Ges. 6, 205 and 269.

protein formation, it is not only a very suitable source of carbon but also enables reductions, and finally yields the necessary energy by supporting respiration.

The utility of glucose (and other carbohydrates) is, however, in connection with the protein still greater than mentioned. It protects—in the fully developed plant at least—the protein against decomposition. It seems that the action of the proteolytic enzyme sets in here with the gradual disappearance of the glucose; as for instance in the case of keeping plants in the dark. If the respiration process finds for support neither fat nor sugar, then the reserve protein is attacked and the amido-acids yield a portion of their carbon for the *wants of respiration*. Another portion of their carbon is transformed into form-aldehyde, their nitrogen into ammonia, and from these two very reactive compounds the innocuous asparagin is formed and stored up for later use. The reserve protein supports here respiration and plays therefore a rôle different from the case of the development of a shoot or of leaf-buds, where the *transportation* of nitrogen is the main object, where a splitting must take place to produce compounds capable of osmosis.[1)]

In many cases this reserve protein is in full grown plants only present in form of *solution* in the vacuole, and may be there as *active* or as *passive* albumen, the latter being easily produced from the former, for instance by dilute acids, perhaps also by enzymes. That the active albumen stands in close connection with asparagin becomes evident in all those cases in which *Borodin* observed the production of asparagin during the development of leaf-buds; here this depends upon a *decrease* of the amount of active albumen stored up in the bark of the twigs, as I have ascertained by the coffeïn reaction (see Chapt. IV). This decrease is also observed if branches of *Fagus*, *Quercus*, or *Betula* are kept in the dark.[2)]

That the *passive* albumen is not formed by direct synthesis

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1) The supposition of several authors that it is the *living protoplasm itself*, that is constantly dissociated into nitrogenous and non-nitrogenous material, the latter serving for respiration, the former being reconstructed to proteids is simply absurd, entirely unchemical and wholly unphysiological (see Chapt. II).

2) This however does not exclude that the passive albumen present, serves the same purpose; moreover the active albumen is passing at first into the passive state before being decomposed into different amido-products.

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but is the *product of the transformation*[1] of the directly formed *active unstable* albumen is plainly logical and needs no further explanation to any one acquainted with the progress of chemistry; it is no "doctrinary assumption," as a botanist in Germany has supposed it to be.

The development and perfection of the sciences causes a growing division of labor but the increased study of details often impedes an insight into the connection of the phenomena of related branches of science. A catalogue of isolated facts, however, accumulated with infinite pains by scientific workers, will have a still fuller significance by the establishment of a unifying conception. The theory here developed combines and compares observations on the lowest as well as the highest forms of vegetation, gives a very plausible account of the mode of protein formation, leads at the same time to a very natural explanation of the chemical difference between living and dead protoplasm, and points to conclusions as to the nature of poisonous actions, which have been verified by experiments.[2]

Still, new theories are making their way very slowly. The history of opinion, says *R. Beeton*, has three stages. The first stage is that in which men say it is not true; the second is that in which they say, there may be something in it, and the third stage is that in which they say they have been of that opinion all along! The theory of the active albumen has now reached the second stage.

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1) Compare pag. 31. Chapt. IV.

2) Compare Chapt. III of this essay.

On the Vegetable Cheese, Natto.

BY

K. Yabe, *Nōgakushi.*

Since remote times there has been prepared in Japan from soya beans, a sort of vegetable cheese called *natto*. The beans are first boiled in water for five hours to render them exceedingly soft. The still hot mass is in small portions wrapped in straw and the bundles thus formed, well tied at both ends, are then placed in a cellar, in the middle of which a fire is kindled, whereupon the cellar is well closed. The heat is left to act for twenty-four hours, after which the product is ready for consumption. Although the moderate heat of the cellar acts only for twenty-four hours, there is still a considerable bacterial change going on. The microbes may be derived either from the air or from the straw. Of course it can not be expected that bacteria on the surface of the soya beans would still be very active. They are probably killed by the five hour's boiling.[1] This product has a peculiar but not putrid smell. The soft mass of the beans is kept together by a very thick viscid substance. In this substance I have found four kinds of microbes present, and the chemical decomposition of proteids must be due to one or more of these microbes.

1. The Microbes of Natto.

A trace of the viscid liquid of the cheese was inoculated in a gelatine solution and a plate culture was prepared. After a few days numerous colonies (1260) appeared, of which four different kinds could be observed, and of these were prepared pure cultures. Three of these different cultures were formed by micrococci, and one by a small, not motile, bacillus liquifying

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1) Exceptional cases where bacteria can stand boiling heat still longer are known, for instance with *Bacillus subtilis*.

gelatine and producing a greenish fluorescence. It forms white flocculent masses on potatoes, and on soya beans it forms white colonies. With regard to the micrococci the colonies of the three kinds can be distinguished by their colors: yellow, orange yellow, and white.[1)]

The yellow micrococcus belongs to the larger kinds. In gelatine it forms white colonies along the canal. At the head of the canal a concavity is formed. The gelatine is in a small degree liquified. On agar, potatoes, and soya beans, it first forms white colonies that gradually turn yellowish. On soya beans it develops the characteristic smell which is observed with *natto* itself. In 2% peptone solution it forms a white deposit.

The orange yellow micrococcus forms round colonies on gelatine. It has a general resemblance to the former but it does not liquify gelatine at all, and produces on soya beans a disagreeable smell. While the former does not spread considerably on potatoes, this one does so forming a slimy cover.

The white micrococcus has a general resemblance, in regard to growth and development of its colonies, to the last named. With regard to the specific smell of *natto*, repeated experiments have convinced me that the above mentioned yellow micrococcus is the chief cause, while with regard to the slimy substance which shows an enormous degree of viscidity further experiments have to be carried out; because the yellow micrococcus is not the cause of this viscidity.[2)]

2. Chemical Investigation.

As the soya bean is very rich in protein, the various decomposition products of proteids might be expected to be present in this cheese to a certain extent. 6.8 kilos. of the raw cheese were extracted with boiling water, and the aqueous solution precipitated with basic acetate of lead. The filtrate from this

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1) White colonies were far less numerous than the others.

2) I made also several experiments to observe the degree of resistance to hydrochloric acid, and found that the microbes mentioned remained alive in 2°/₀ peptone solution containing 0,11 °/₀ HCl, but they were killed when hydrochloric acid was increased to 0,19°/₀.

precipitate was mixed with mercuric nitrate with the gradual addition of small quantities of soda as long as a precipitate was formed. This precipitate, after being washed well on a filter, was decomposed by sulphuretted hydrogen, and the filtrate evaporated on the water bath, ammonia being, from time to time, added to keep the solution neutral. In the concentrated liquid were formed after some time white crystalline masses composed of radiating needles of the forms characteristic of *tyrosin*. They were easily soluble in dilute ammonia and in hydrochloric acid, slightly soluble in cold, and easily in hot, water. They were purified by repeated recrystallisation, and then yielded the reaction of *Piria*, *Wurster* and *Hofmann* for *tyrosin*. The determination of nitrogen by *Kjeldahl's* method yielded 7,98 %, while the theory requires 7,75 %. Also the copper compound was obtained by boiling the solution with copper hydrate and filtering while hot. The total quantity obtained amounted to 3.212 grm. The mother liquor from which the tyrosin was separated was farther concentrated and divided into two parts (a) and (b). The part (a) was precipitated with phosphotungstic acid after the addition of a little sulphuric acid (c) and the filtrate mixed with caustic baryta to separate the sulphuric acid and phosphotungstic acid. After the removal of the excess of baryta by a current of carbon dioxide, the filtrate was evaporated. Numerous spherocrystals were obtained with the behavior of leucin mixed with the crystals of ammonium nitrate. To remove the latter, a little baryta was added and by evaporation the ammonia was expelled. When the residue was treated with alcohol, barium nitrate remained behind while the alcoholic solution on evaporation yielded crystals of leucin which were converted into the characteristic copper compound which yielded on analysis 19.76% copper, while the formula $(C_6 H_{12} NO_2)_2 Cu$ requires 19,5%.

The phosphotungstic precipitate (c) was first washed with cold water containing some sulphuric acid and then decomposed in the usual way with caustic baryta and the filtrate after removal of the excess of baryta evaporated, whereby a syrupy liquid was obtained. I searched here for lysin, lysatinin (both discovered by *Drechsel*) and arginin (discovered by *Schulze*), which are the decomposition products of the proteids of the germinating lupines, but all my efforts were in vain. The syrup gave, however, all

reactions of *peptone* and consisted for the most part of this substance.

The above mentioned part (b) was treated with ammoniacal solution of silver nitrate whereby a small amount of a white precipitate was obtained which was collected on a filter and washed with dilute ammoniacal solution of silver nitrate, then dissolved in warm nitric acid of sp. gr. 1,1 with the addition of little urea. Upon cooling, microscopical needles were obtained, which proved to be a mixture of the silver compound of guanine and of hypoxanthin. After the removal of the silver with sulphuretted hydrogen, filtering and evaporating with the addition of a little ammonia, a residue was obtained, soluble with great difficulty in water and alcohol but easily soluble in mineral acids. It was treated with ammonia whereby a part was dissolved and a part not. The latter gave the sharp reaction of *Capranica* for *guanine*. When dried with nitric acid in a platinum dish it gave a yellow residue, which turned red on the addition of soda. The former, i. e., the soluble part was obtained by evaporationg the ammoniacal liquor. When evaporated in a platinum dish with nitric acid, and the residue treated with caustic potash, no coloration took place. The reaction of *Weidel* and of *Capranica* did not leave any doubt that this substance was hypoxanthin, but there was contained also xanthin in the cheese. This was obtained by adding ammonia to the filtrate separated from the first crystallisation of the guanine and hypoxanthin silver compounds. By adding ammonia, a yellowish flocculent precipitate was obtained from which the silver was removed by sulphuretted hydrogen. The filtrate then evaporated to dryness left a faintly yellowish powder slightly soluble in water, insoluble in alcohol and ether, but easily soluble in alkalies and acids. On treating it with nitric acid a yellow residue was obtained turning red upon the addition of soda and purple on heating. The reaction of *Hoppe-Seyler* and *Weidel* left no doubt that this substance was xanthin. Whether these substances of the xanthin series were formed by the bacterial action during twenty-four hours in the warmed cellar is doubtful. I think it is more probable that they were originally present in the soya bean. But there can be no doubt that a large portion of peptone, and also leucin and tyrosin

were products of the bacterial action. Considering the high temperature of the warmed cellar, the considerable extent of the bacterial decomposition is not very surprising. There can hardly be any doubt that the *natto*-preparation is more easily digestible than the original soya bean, as it is very soft [1] and contains more peptone.

We add finally the determination of the different forms of nitrogen in the soya been and in *natto*.

	Soya bean.	Natto prepared from the same soya bean.
Total nitrogen.[2]	7,355 %	7,542 %
Nitrogen of proteids (excluding peptone)	6,899	4,033
Nitrogen of amides	0,128	1,892
Nitrogen of peptone	0,328	1,617.

1) While the water of the air-dry soya bean, amounted to 15,16 %, that of *natto* amounted to 59,12%.

2) The relative increase of total nitrogen in *natto* may be chiefly due to the loss of carbon as carbon dioxide during the fermentation.

On the Poisonous Action of the Hydroxyl-derivatives of Benzol upon Yeast and Bacteria.

BY

K. Yabe, *Nōgakushi.*

The toxical action of phenol, of the dioxybenzols (resorcin, pyrocatechin and hydrochinon) and of the trioxybenzols (phloroglucin,[1]) pyrogallol) has been compared in regard to animals but not yet in regard to the lower fungi. As a general rule, it has been found that the poisonous character increases with the number of hydroxyl groups entering into the benzol ring. *Stolnikow* observed that phloroglucin is more poisonous for frogs than resorcin, and this is again more poisonous than phenol. While the lethal dose of phenol for warm-blooded animals is 0,3-0,7 gr. per kg., 0,08 gr. resorcin is found to be sufficient (*Zeni* and *Betelli*). The three isomeric dioxybenzols show a very great difference in their toxical action. Pyrocatechin is strongest, then follows hydrochinon and finally resorcin. Of the trioxybenzols, phloroglucin is less poisonous than pyrogallol. Loew[2]) observed that in 1 per mille phenol solution some infusoria still remained alive after 15 hours, and certain algæ have been found alive after three days, while pyrocatechin solution of the same strength killed infusoria and diatoms after a few minutes, spirogyra after several hours. Hydrochinon acts somewhat more slowly, but in resorcin solution of that strength infusoria live several hours, and algæ are found alive even after 18 hours. The phenol character is here evidently increased by the toxical effect caused by the capability of absorbing oxygen. Pyrocatechin and hydrochinon will rob the cells of the dissolved molecular oxygen much more quickly than phloroglucin, and consequently we find with the former also a much more poisonous character.

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1) The third isomeride, oxyhydrochinon, has not yet been physiologically studied.

2) Natürliches System der Giftwirkungen, p. 50-51.

It seemed to be of interest to compare these different phenols in relation to yeast and bacteria as it has been recently asserted by *Biernacki* (*Pflüg. Arch.* 49, 112) that phenol is a stronger poison for yeast than pyrogallol which would be an exceptional case, the alcoholic fermentation being prevented by the following solutions:—

Phenol.....1 : 200
Resorcin.....1 : 100
Pyrogallol.....1 : 50.

For this purpose, equivalent quantities of different phenols were dissolved in *Pasteur* solution, and yeast added. The results are shown in the following table:—

Phenol	0,5% no fermentation.	0,4% no fermentation.
Pyrocatechin	0,585 ,, ,,	0,468 ,, feeble fermentation.
Resorcin	0,585 fermentation.	
Hydrochinon	0,585 ,,	———
Pyrogallol	0,670 ,,	———
Phloroglucin	0,670 ,,	———

In a second experiment, yeast was shaken first with the solutions of these phenols and left to stand for 70 hours. After decantation of the liquid, the yeast was put in *Pasteur* solution with the following results:

Phenol	0,3% fermentation.	0,4% no fermentation.
Pyrocatechin	0,351 ,,	0,468 feeble fermentation.
Resorcin	0,351 ,,	0,468 fermentation.
Hydrochinon	0,351 ,,	0,468 ,,
Pyrogallol	0,402 ,,	0,536 ,,
Phloroglucin	0,402 ,,	0,536 ,,

Phenol	0,45%	no fermentation.
Pyrocatechin	0,527	,,
Resorcin	0,527	fermentation.
Hydrochinon	0,527	feeble fermentation.
Pyrogallol	0,603	,,
Phloroglucin	0,603	fermentation.

The same experiment has been carried out with bacteria. A drop of putrid peptone solution was mixed with 50 c. c. of the

equimolecular solutions of phenols and left to stand for 70 hours. Afterward traces of the different liquids were inoculated in sterilised peptone solution with the following results:—

Phenol	,4%	no development.
Pyrocatechin	,468	,,
Resorcin	,468	development.
Hydrochinon	,468	no development.
Pyrogallol	,536	development.
Phloroglucin	,536	,,

We observe here, therefore, an exception to the rule, the higher hydroxylated benzols are in the case of the lower fungi less poisonous than phenol itself. Further experiments must be made to bring out a scientific explanation of this exceptional behavior.

On the Quantity of Wood-gum (Xylan) contained in Different Kinds of Wood.

BY

J. Okumura, *Nōgakushi.*

The durability of wood is of great importance for industrial purposes. This durability depends not only upon the greater or less density, but also upon the presence of certain chemical constituents. Thus a certain proportion of resinous matters will increase the durability, while the presence of easily soluble carbohydrates may diminish it considerably. The durability consists in a certain resistance to the attacks of different kinds of fungi, as *Polyporus*, *Agaricus*, etc. Resinous matters can never be attacked by these fungi, but various carbohydrates, as starch, wood-gum, and even cellulose are sometimes rapidly dissolved by the ferments produced by these fungi which thus prepare their way to penetrate into the interior of the wood.[1] From this stand-point it seemed to me to be of great interest to determine the amount of wood-gum in a series of trees grown in Japan. Of course the quantity of wood-gum will not be found always to be a constant figure. The proportion may differ somewhat between the heart-wood and bark, and also may vary with the age of the tree. It is certainly of physiological interest that *Thomsen* found great differences in the amount of wood-gum in sap-wood and heart-wood as seen from the following table:—

Dried at 100°C.	% in dry matter.	
	Sap-wood.	*Heart-wood.*
Betula alba L. (old)	13.9	19.7
,, (young)	24.9	26.4
Fagus sylvatica, L. (100 years old)	8.2	15.9
,, (young)	11.9	11.3
Quercus glandulifera, Bl.	14.4	10.7
Prunus pseudocerasus, L.	19.3	15.4

1) The observations of *R. Hartig* in this direction are of special importance.

Fraxinus pubinervis, Bl.	9.7	10.7
Ulmus parvifolia, Jacg	8.9	12.0.

The samples which I took for the determination of wood-gum were collected from the specimens that belong to the forestry department of our college. 5 grams of the finely powdered air-dried wood[1] were extracted with 50 c.c. of 5% solution of caustic soda. After standing for 24 hours with occasional stirring it was filtered and washed with cold water. The filtrate was then mixed with hydrochloric acid until a weak acid reaction was perceptible. The flocculent precipitate was then collected on a weighed filter and dried at 100°C. to constant weight. In this way I obtained the following results:—

		Percentages of wood-gum in the dry matter.
1) Cryptomeria japonica, Don.	(Coniferæ)	1.742
2) Thuya obtusa, B. et H.	(,,)	2.357
3) Pinus parviflora, S. et Z.	(,,)	4.212
4) Ginkgo biloba, L.	(,,)	2.519
5) Pinus thumbergii, parlat.	(,,)	4.560
6) Abies firma, S. et Z.	(,,)	0.961
7) Torreya nucifera, S. et Z.	(,,)	2.727
8) Podocarpus macrophylla, Don.	(,,)	2.914
9) Zelkowa acuminata, Planch.	(Ulmaceae)	13.240
10) Castanea vulgaris, Lam. var. japonica, DC.	(Cupuliferae)	4.776
11) Fagus Sieboldi, Endl.	(,,)	19.716
12) Quercus acuta, th.	(,,)	6.609
13) Alnus incana, wild. var. glauca, Ait.	(Betulaceae)	6.852
14) Phellodendron amurense, Rupr.	(Rutaceae)	6.586
15) Magnolia hypolenca, S. et Z.	(Magnoliaceae)	10.327
16) Cladrastis amurensis, B. et H. var. floribunda, Maxim.	(Legminaceae)	11.964
17) Melia azedarach, L. var. subtripinnata, Mig.	(Maliaceae)	2.634
18) Ternstrœmia japonica, th.	(Ternstromiaceae)	3.813

1) All of these were sap-wood except that of Cryptomeria japonica.

19) Acanthopanax innovans, S. et *Z.* (Araliaceae) 8.409

20) Juglans mandshurica, Maxim. (Juglandaceae) 6.985

21) Phyllostachys nigra, Munro. (Gramineae) 6.234

We see, therefore, that the Coniferæ are comparatively poor in wood-gum, and Ternstrœmia and Melia are also poor. Cupuliferæ are richer, Juglans, Magnolia, Cladrastis, Acanthopanax, etc. are still more so.

On the Reserve Protein in Plants.

BY

G. Daikuhara, *Nōgakushi.*

While in the seeds the reserve protein forms small globules called aleuron, it is with fully developed plants in many cases not yet decided how the reserve protein occurs. It is, however, generally supposed that albumen is present in solution in all the plant juices and this albumen may be used up in all those instances when a considerable amount is wanted at a certain time, as for instance during the ripening of the seeds. Recent investigations have shown, however, that the albumen dissolved in the vacuole is not always the ordinary or *passive* albumen, but in many cases a very unstable albuminous body which is closely related to the albuminous substance in the living protoplasm, and which has been called *active* albumen. This changes its nature soon after the cell dies, and is turned into the ordinary or passive albumen. In many cases, however, this active reserve protein in the vacuole is changed in this way while the cells are still alive. It has not yet been determined how far this active albumen is connected with the production of amido-compounds which takes place when the branches of trees are placed in water, or when entire plants are kept deprived of light, or when leaf-buds develop on the branches in the spring. I have made, therefore, a series of experiments to obtain some information about the function of the active albumen which is found in the bark, leaves, flowers, and roots of numerous trees, as *Quercus*, *Tilia*, *Pæonia*, *Fagus*, *Prunus*, etc. This active albumen can be easily found by treatment with coffein under the microscope. Cells containing it will show at first numerous little globules in the vacuole, which flow together to one or several large drops,

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1) See *Loew* and *Bokorny*, Flora 1892; and Biol. Centralbl. 1891.

called *proteosomes*, with a high refractory power for light.[1] Upon treatment with iodine solution, they assume a yellow tinge and lose their brightness entirely, showing either numerous little vacuoles or one large one and being then hollow spheres. To distinguish them from starch granules or fat drops is, therefore, a very easy matter. Sometimes it suffices to take a little piece of fresh bark or a leaf and tear it into little particles in a drop of coffein solution and observe the result at once under the microscope with a high magnifying power. Thus, not only the bright drops mentioned can be seen very soon, but also in some early dying cells the change from the bright drops to hollow spheres can be observed even without killing with iodine.

With regard to the behavior of the proteosomes, I observed the following: the petals of *Saxifraga sarmentosa* which had remained in cold saturated coffein solution and showed then numerous proteosomes, were left for 15 hours partly in 1 % HCl, partly in 1 % HNO_3, and partly in dilute phosphotungstic acid. The proteosomes were not dissolved but had become turbid. Nitric acid had produced a yellowish coloration which became stronger on heating.

The petals of *Punica granatum* were, after treatment with coffein, placed (a) partly in 1 p. mille NH_3, (b) partly in 1 % acetic acid and (c) partly in alcohol of 20 %. After 4 hours it was observed that the dilute NH_3 had not produced any vacuoles in the proteosomes; it seemed that they had become solid, and neither absolute alcohol nor NH_3 of 10 % nor acetic acid of 1 % changed them any farther. The portion exposed to the dilute acetic acid (b) showed coagulated masses of irregular form which were not changed any more by absolute alcohol. A portion of proteosomes seemed to have been partly dissolved. Those proteosomes (c) which had remained 4 hours in alcohol of 20 % were partly transformed to hollow spheres, partly to irregular masses which experienced no farther change by treatment with absolute alcohol.

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1) Dead cells never give proteosomes on treatment with coffein. If leaves of Pæonia albiflora, for instance, are left for 24 hours in 1 °/₀ acetic acid or for 1 hour in vapors of ether, coffein will not produce any more proteosomes while the fresh leaves give a very strong reaction.

By exposure to boiling 5% NaCl solution the proteosomes were coagulated. This was observed with the petals of *Punica* and of *Astilbe* and the root of *Thesium*.

Millon's and biuret reactions are best made on objects free from tannin, as for instance, the root of Thesium. Both reactions were obtained after fixation of the proteosomes by dilute ammonia after the modification, described by *Loew* and *Bokorny* (Bot. C. 1889); biuret reaction was also obtained by boiling with a concentrated solution of copper sulphate solution, washing and moistening with concentrated solution of caustic potash.

A small branch of *Quercus dentata*, showing in the young leaves as well as in the bark, during development in the spring, a large quantity of active albumen, was left for twelve days with the stem immersed in water. At the same time two of the leaves were placed in a small vessel with water. In the latter case, the respiration was of course restricted to a certain extent for obvious reasons. Both objects were placed in a corner of a room with only a moderate amount of light [1] for twelve days, and then for two days in the dark. Now the leaves on the branch commenced to show brown spots, whereupon a microscopical examination was made and it was found that there was no longer any starch in either case, but while the leaves on the branch no longer showed the reaction of active albumen, those kept in water still gave a moderate reaction. It might be objected here that there was just as much albumen still present in the former leaves, but it was only changed to *passive* albumen. But it has been shown by *E. Schulze* that protein compounds are transformed in plants kept in darkness into amido-acids, and that finally asparagin remains as a chief product.

The gradual disappearance of the active albumen from the leaves stands in close relation to the formation of asparagin; I found that while the fresh leaves of *Quercus glandulifera* contained 0.218% of nitrogen in the form of asparagin (determined after *Sachse-Kormann*), those kept for seven days in darkness contained 0.606%; therefore the asparagin was increased nearly three times the original amount.

A similar experiment was made with the leaves of *Pæonia*

1) At the lower end of the branch a fresh surface was cut repeatedly in order to secure the sufficient ascent of water.

albiflora, which were kept for 25 days in a large glass jar containing some water in order to secure perfect saturation of the air with aqueous vapor. The vessel was covered with a glass plate and exposed to a temperature of 25–30°C. in the dark. The air was from time to time renewed. After 25 days the leaves commenced to show black spots and the still healthy part of the leaves failed in many cells to give proteosomes by treatment with coffein, while in the beginning an exceedingly strong reaction, especially in the epidermis-cells, had been observed. The decrease of the amount of active albumen stands evidently in close relation to the production of asparagin also in this case where the amount of asparagin was increased considerably as seen from the following result :—

	Fresh leaves.	Starved leaves.
Total N.	2.222 %	2.648 %
Album. N.	1.890 „	1.414 „
Asparagin N.	0.219 „	1.211 „
Total N : Aspar. N. ...	100 : 9.86	100 : 45,72

In order to determine whether the active albumen occurs very frequently in plants, I made numerous microscopical examinations, the results of which are shown in the following tables. While a large number of plants contain in different parts active albumen in the vacuole, other plants contain only passive, and again others do not store up any albuminous matter at all in the fully developed tissues. Such parts of plants as grow just as quickly as the formation of albumen proceeds, will of course not be able to store up the latter. Other plants may convert, either by acids or by ferments,[1] the active albumen in their vacuole, as soon as it is formed, into passive. Thus, for instance, the leaves of *Diospyros* contain neither active nor passive albumen, the leaves of *Vicia* contain only passive albumen, while the

1) To decide whether a ferment is the cause of this change in some plants, a cold extract of leaves of Vicia Faba was left to act upon small pieces of the leaves of Paeonia but no decrease of the active albumen in the cells of the latter was noticed after 24 hours. Of course it may be doubtful whether a ferment present could have entered easily into the living tissue.

leaves of *Prunus* contain a large amount of active albumen. The passive albumen may easily be found in leaves that do not contain active albumen, by crushing them in a mortar, adding water, filtering, and adding nitric acid to the filtrate. The coagulation by this acid or by heat leaves no doubt that albumen was present. Some biological relations of interest are recognized from the inspection of the following tables :—

ROSACEAE.

Species.	Objects tested.	Active albumen.	Remarks.
Prunus persica.	Young leaves.	Present.	No starch.
Prunus pseudocerasus.	Young leaves.	Much present.	No starch.
,, ,,	Epidermis of root.	Present.	No starch.
,, ,,	Inner tissue of root.	None.	Much starch.
Pyrus japonica.	Young leaves.	Present.	No starch.
,, ,,	Roots.	None.	
Photinia glabra.	Young leaves.	Much present.	Much starch.
,, ,,	Flowers.	Much present.	
Rosa lævigata.	Young leaves.	Much present.	No starch.
,, ,,	Flowers.	Much present.	No starch.
Rosa Banksiæ.	Roots.	Present.	No starch.
Kerria japonica.	Young leaves.	Much present.	No starch. Neutral reaction.
Rubus palmatus.	Young leaves.	None.	Neutral reaction.
,, ,,	,, berries.	None.	Acid reaction.
Rubus Thumbergi.	Young leaves.	None.	No starch.

PALMEAE.

Trachycarpus excelsa.	Young buds.	None.	No starch.

CUPULIFERAE.

Species.	Objects tested.	Active albumen.	Remarks.
Quercus glandulosa.	Young leaves.	Much present.	No starch.
,, ,,	Roots.	Present.	Neutral reaction.
Quercus dentata.	Young leaves.	Much present.	Much starch.
Quercus acuta.	Young leaves.	Much present.	No starch.
Castanea fesca.	Young leaves.	Much present.	No starch. Acid reaction (trace).

TERNSTROEMIAOEAE.

Camellia japonica.	Young leaves.	Present.	No starch.
Camellia theafera.	Young leaves.	Present.	Little starch.
,, ,,	Roots.	Trace.	Little starch.
Eurya japonica.	Young leaves.	None.	

SIMARUBIAE.

Ailanthus glandulosa.	Young leaves.	Much present.	Slightly acid reaction.
Picrasma ailanthoides.	Young leaves.	Present.	
Melia Azedararch.	Young leaves.	None.	Much starch.

HAHAMERIDEAE.

Distylium racemosum.	Young leaves.	None.	
Corylopsis pauciflora.	Young leaves.	Present.	

1) The same species grown in the shade of large trees contained neither active albumen nor starch.

ORCHIDEAE.

Species.	Objects tested.	Active albumen.	Remarks.
Bletia Hyacinthina.	Young leaves.	Present.	No starch.
,, ,,	Flowers.	Present.	No starch.
,, ,,	Roots.	Present.	No starch.
,, ,,	Tubers.	Present.	No starch.
Gastrodia elata.	Flowers.	Much present.	No starch.
,, ,,	Tubers.	Much present.	No starch.
Cynbidium virens.	Young leaves.	None.	
,, ,,	Roots.	None.	
Iris tectorum.	Young leaves.	None.	No starch.
,, ,,	Roots.	Much present.	No starch.

RANUNCULACEAE.

Pæonia albiflora.	Young leaves.	Much present.	
,, ,,	Flowers.	Much present.	
,, ,,	Tubers.	Present.	Slightly alkaline reaction.
Pæonia Moutan.	Young leaves.	Much persent.	No starch.
,, ,,	Young roots.	Present.	No starch.
Clematis florida.	Young leaves.	None.	No starch.
	Flowers.	None.	Neutral reaction.

MALVANCEAE.

Hibiscus syriacus.	Young leaves.	None.	Much starch. Neutral reaction.

ULMACEAE.

Species.	Objects tested.	Active albumen.	Remarks.
Zelkowa acuminata.	Young leaves.	Present.	
,, ,,	Roots.	None.	
Ulmus parvifolia.	Young leaves.	Present.	No starch.

ELAEAGINEAE.

Eleagnus pungens.	Young leaves.	None.	Little starch.

MAGNOLIACEAE.

Cercidiphyllum japonicum.	Young leaves.	Much present.	No starch.
Schizandra chinensis.	,, ,,	None.	Much starch.
,, ,,	Young seeds.	None.	Much starch.

LYTHRARIAE.

Punica Granatum.	Young leaves.	None.	
,, ,, 1)	Flowers.	Much present.	
Lagerstrœmia indica.	Young leaves.	Much present.	

PAPAVERACEAE.

Papaver somniferum.	Young leaves.	None.	Much starch.
,, ,,	Flowers.	None.	Neutral reaction.
,, ,,	Unripe seeds.	None.	

1) Antipyrin acts just as coffein on the active albumen, but its action is much slower than that of coffein.

MORACEAE.

Species.	Objects tested.	Active albumen.	Remarks.
Morus alba.	Young leaves.	None.	No starch.
,, ,,	,, ,,		Much pass. albumen.
,, ,,	,, ,,		Neutral reaction.

ARALIACEAE.

Helwingia japonica.	Young leaves.	Present.	Much starch.
,, ,,	,, ,,		Neutral reaction.
Acanthopanax aculeatum.	Young leaves.	Present.	No starch.
,, ,,	Roots.	None.	

OLEACEAE.

Ligustrum ibota.	Young leaves.	None.	
Syringa vulgaris.	Young leaves.	None.	Little starch.
,, ,,	,, ,,		Little pass. albumen.

CAPRIFOLIACEAE.

Viburnum dilatatum.	Young leaves.	None.	No starch.
Sambucus racemosa, var. Sieboldiana.	Young leaves.	None.	

POLYGONACEAE.

Species.	Objects tested.	Active albumen.	Remarks.
Polygonum cuspidatum.	Young leaves.	Present.	
Fagopyrum esculentum.	Young leaves.	None.	
,, ,,	Flowers.	Much present.	No starch.
,, ,,	Roots.	None.	Much starch.

LAURACEAE.

Cinnamomum Camphora.	Young leaves.	None.	Much starch.
Machilus Thunbergi, var. Major.	Young leaves.	None.	No starch.

SOLANACEAE.

Physalis Alkekengi.	Young leaves.	None.	Much starch.
,, ,,	Flowers.	None.	Much starch.
,, ,,	Roots.	None.	Much starch.
Solanum tuberosum.	Young leaves.	None.	Little starch.
,, ,,	Flowers.	None.	No starch.

STERCULIACEAE.

Sterculia platanifolia.	Young leaves.	Present.	

CORONACEAE.

Aucuba japonica.	Young leaves.	None.	

SAXIFRAGEAE.

SPECIES.	OBJECTS TESTED.	ACTIVE ALBUMEN.	REMARKS.
Saxifraga sarmentosa.	Young leaves.	Much present.	
,, ,,	Flowers.	Much present.	
,, ,,	Roots.	Much present.	
Deutzia scabra.	Young leaves.	None.	No starch.
,, ,,	Flowers.	None.	Much starch.
,, ,,	Roots.	None.	
Astilbe japonica.	Young leaves.	Present.	The proteosomes contracted here by treatment with iodine in such a way that a number of radial fissures were formed.
,, ,,	Flowers.	Present.	
Hydrangea paniculata.	Young leaves.	None.	

VERBENACEAE.

Premna japonica.	Young leaves.	None.	Little pass. albumen.
,, ,,	Flowers.	None.	
Callicarpa japonica.	Young leaves.	Much present.	

SANTALACEAE.

Thesium decurrens.	Young leaves.	None.	Little starch.
,, ,,	Roots 1).	Much present.	
,, ,,	Flowers.	Trace.	

1) If we make a vertical cut through the surface of the root, we can observe under the microscope in many cells globular masses consisting of active albumen which may have been separated from the dissolved albumen by mechanical action but after treatment with coffein the quantity is considerably increased. There is present much tannin in the hot water extracts of the stem but not in those of the root.

CORYLACEAE.

Species.	Objects tested.	Active albumen.	Remarks.
Carpinus cordata.	Young leaves.	Present.	No starch.

BETULACEAE.

Alnus maritima.	Young leaves.	Much present.	No starch.

ALISMACEAE.

Alisma Plantago.	Young leaves.	Present.	Much starch.

EBENACEAE.

Diospyros kaki.	Young leaves.	None.	No pass. albumen.
,, ,,	Flowers.	None.	Neutral reaction.
,, ,,	Seeds.	None.	

DIOSCOREAE.

Dioscorea japonica.	Young leaves	None.	No starch
,, ,,	,, ,,		Neutral reaction
,, ,,	,, ,,		Much pass. albumen[1].
,, ,,	Roots.	None.	Neutral reaction.

SALICINEAE.

Salix japonica.	Young leaves.	None.	No starch.

1) In this root is also contained about 8 % of the dry matter mucin, according to J. Ishii. See this Bulletin, p. 99.

SAPINDACEAE.

Species.	Objects tested.	Active albumen.	Remarks.
Acer palmatum.	Young leaves.	Present.	Also leaves suffering from albinism gave the reaction.
,, ,,	Roots.	Present.	

LILIACEAE.

Lilium collosum.	Young leaves.	None.	
,, ,,	Roots.	None.	
Hemerocallis flava.	Young leaves.	None.	Little pass. albumen.
,, ,,	Roots.	None.	No starch.
Polygonatum canaliculatum.	Young leaves.	None.	No starch.
Polygonatum canaliculatum.	Flowers.	None.	No starch.

RUBIACEAE.

Gardenia florida.	Young leaves.	None.	Much pass. albumen.
,, ,,	,, ,,		Much slimy matter.

BERBERIDIEAE.

Nandina domestica.	Young leaves.	None.	No starch.
,, ,,	Buds.	Much present.	No starch.

ONAGRACEAE.

Oenothera Jacquinii.	Young leaves.	Much present.	No starch.
,, ,,	Flowers.	Much present.	No starch.
,, ,,	Roots.	Much present.	No starch.

CARYOPHYLLEAE.

Species.	Objects tested.	Active albumen.	Remarks.
Lychnis floscucculi.	Young leaves.	None.	
,, ,,	Flowers.	None.	
Dianthus superbus.	Young leaves.	None.	Little starch.
,, ,,	Roots.	None.	Pass. albumen is found very much in the leaves.

GRAMINEAE.

Arundinaria japonica.	Young leaves.	None.	No starch.
,, ,,	Roots.	None.	Immense quantity of starch in the interior tissue.
	Young shoots.	None.	Much starch.
			Neutral reaction.
Bambusa senanensis.	Epidermis of young seeds.	Present.	Much starch.
Triticum vulgare.	Epidermis of young seeds.	Present.	Little starch.
Brachypodium japonicum.	Epidermis of young seeds.	Much present.	Much starch.
Hordeum disticum.	Epidermis of young seeds.	None.	Much starch.
Avena sativa.	Epidermis of young seeds.	None.	Much starch.

CRUCIFERAE.

Raphanus sativus.	Flowers.	None.	No starch.

In the root of almost all species of plants, the epidermis is generally richer in active albumen than the interior tissue, while the starch is generally wanting in the epidermis.

Often the active albumen decreases in those leaves that are nearest to the flowers, if the latter are very rich in active albumen.

LEGUMINOSAE.

Species.	Objects tested.	Active albumen.	Remarks.
Vicia sativa.	Young leaves.	None.	Much pass. albumen.
,, ,,	Epidermis of seeds.	None.	Much starch.
Vicia sativa.	Roots.	None.	Neutral reaction.
Vicia Faba.	Young leaves.	None.	Much pass. albumen.
,, ,,	Epidermis of seeds.	None.	Much starch.
Vicia Faba.	Roots.	None.	Neutral reaction.
Vicia unijuga.	Young leaves.	None.	Much pass. albumen. (Neutral reaction).
Lespedeza sericea.	Young leaves.	None.	
,, ,,	Roots.	None.	
Wistaria chinensis.	Young leaves.	None.	No starch.

CONIFERAE.

Ginkgo biloba.	Young leaves.	None.	Little starch.
,, ,,	Roots.	None.	

RUTACEAE.

Citrus fusca,	Young leaves.	None.	No starch.
,, ,,	Roots.	None.	Much starch.
Xanthoxylum piperitum.	Young leaves.	Much present.	Little starch.
,, ,,	Roots.	Much present.	Little starch.
Orixa japonica.	Young leaves.	None.	Much starch.

COMPOSITAE.

Species.	Objects tested.	Active albumen.	Remarks.
Hieracium umbellatum.	Leaves.	None.	Acid reaction.
Leucanthemum Chrysanthemum.	Young leaves.	None.	Much starch.
Leucanthemum Chrysanthemum.	Flowers.	None.	No starch.
Leucanthemum Chrysanthemum.	Roots.	None.	No starch.
Petasites japonica.	Young leaves.	None.	Much starch.

MENISPERMACEAE.

Cocculus indicus.	Young leaves.	None.	
Menispermum dahuricum.	Leaves.	None.	
,, ,,	Flowers.	None.	

CONVOLVULACEAE.

Ipomaea hederacea.	Young leaves.	None.	No starch.
,, ,,	Roots.	None.	Much starch.

ANACARDIACEAE.

Rhus semi-alata,	Young leaves.	Present.	Much starch.
var. Osbeckii.	Roots [1]).	Present.	

ERICACEAE.

Pieris japonica.	Young leaves.	Present.	No starch.

1) In the root the active albumen is less than in the leaves.

UMBELLIFERAE.

Species.	Objects tested.	Active albumen.	Remarks.
Daucus carota.	Nerves of leaves.	Present.	
Thorylis anthriscus.	Nerves of leaves.	Present.	

ILICINEAE.

Ilex pedunculosa.	Young leaves.	Present.	No starch.
	Flowers.	Present.	No starch.

LINACEAE.

Reinwardtia trigyna.	Young leaves.	None.	Little starch.
	Flowers.	None.	Little starch.

CELASTINEAE.

Evonymus japonicus.	Young leaves.	None.	Little starch.
	Leaves suffering from albinism.	None,	Little starch.
	Elowers.	Present.	Little starch.

From these tables it will be seen that of 104 species of plants, 51 contained albumen stored up, in one part or another, active while 53 did not contain it at all.

The plants examined belonged to 52 families.

The active albumen was found in 29 families.

It is of physiological interest to see how the active albumen often accumulates in the flowers and that in such cases it may be absent in the green leaves or decrease in those parts that are nearest to the flower (compare the above observations with *Punica Granatum*, *Nandina domestica*, *Evonymus japonica* and *Fagopyrum esculentum*). In Gramineae I found active albumen thus far only in the epidermis of seeds and only in a certain period of development.

In the shade active albumen is formed in smaller quantities than in full sun-light; I found much of it in the leaves of *Ailanthus glandulosa* in the latter case, but none in shade-plants. Further, the young leaves are richer in it than old ones. Leaves suffering from albinism show it in the white parts of their leaves about just as much as in the green parts (observation with *Acer palmatum*).

On the Occurrence of Mucin in Plants.

BY

J. Ishii, *Nōgakushi.*

In the animal as well as in the vegetable kingdom, there are found substances of slimy nature, which serve for different physiological functions; but while the slimes of animals belong to the protein compounds, all plant-slimes consist, so far as is yet known, of carbohydrates, corresponding either to the formula $C_6H_{10}O_5$ or $C_{12}H_{22}O_{11}$ and yielding by hydrolysis different kinds of sugar; as, for instance, carrageen or the slime of an alga *Chondrus crispus Lyngb*) yields galactose (*Hädicke*, *Bauer* and *Tollens*), cerasin or the gum of the cherry-tree yields arabinose (*Scheibler*, *Kiliani*), and the slime of beer-yeast yields mannose (*Hessenland*).

As a number of Japanese plants are so rich in slimy matters as to be applied on account of this quality for industrial purposes, I believed it to be, from a physiological as well as a technical point of view, of some interest to investigate their proper chemical relations. To my surprise I have found in the tuberous root of yams a slimy matter that is *precipitated from its solution by dilute acetic acid.* Further investigation has demonstrated beyond any doubt, that this *slime* belongs to the *class* of *mucins*, and as this remarkable occurrence is the first exception to a generally adopted rule, I will describe in the following lines my observations in detail.

1. Short Description of Japanese Yams.

There are two kinds of yams growing in this country, the one is called "*yamano-imo*" (Dioscorea japonica, Humb.) while the other is called "*jinenjo*" (Dioscorea batatas, Decaigne.) Both of them are found in a wild state and are very often cultivated. "*Naga-imo,*" "*tsukune-imo*" and "*ichinen-imo*" are indeed the names given to the three different cultivated forms of "*jinenjo.*" All of these forms produce the large tuberous roots which are used as food.

Composition of the yam.[1])	
Water	80.74
In 100 parts of dry matter,	
Crude protein	11.74
Fat	0.84
Fibre	4.36
Ash (free from Co_2)	3.60
Starch	22.13
Other non-nitrogenous substances.	57.33
Total nitrogen	1.879
Nitrogen in amides, etc.	0.675

2. Preparation of the Slime of Yams.

The slimy matter forms a thick turbid liquid and can be easily freed from starch granules and other substances by simply filtering. The filtered liquid shows a neutral reaction, and is precipitated by the addition of acids, but the precipitation is prevented to a certain extent by the presence of common salt. Several methods are proposed for the isolation of mucin.

Landwehr[2]) prepared the mucin of the bile by precipitating with acetic acid, washing, dissolving in 1% solution of soda, and precipitating again. *Obolenski*[3]) recommended a method of purifying the mucin of the submaxillary glands as follows: The glands are soaked in water over a night and filtered. The filtrate is precipitated with acetic acid, the precipitate washed first with water and a little acetic acid, then with hot alcohol and finally dried. But *Hammarsten*[4]) recommended a new method which is well adapted to separate mucin from substances belonging to the group of nucleoalbumins. The mucin of the submaxillary glands is soluble in dilute hydrochloric acid (0.1—0.2%) and is precipitated unchanged by adding 3 or 4 times its volume of water to the solution, while the nucleoalbumin dissolves in dilute hydrochloric acid together with the mucin,

1) The analysis was made in the agricultural chemical laboratory of the Imperial College of Agriculture in Tōkyō. See Bull. Vol. I.

2) Z. physiol. Chem. Bd. V, 371.

3) Pflüg. Arch. 4.

4) Z. physiol. Chem. Bd. XII.

but is not precipitated by adding water. As the precipitate obtained by the addition of acetic acid to the extract of yam root was insoluble in dilute hydrochloric acid and with difficulty soluble in very dilute alkali (as 1% solution of caustic soda), I worked chiefly according to the method of *Obolenski*.

The roots were cut into small slices, well crushed and extracted with about three times the volume of water under frequent stirring; the thick liquid thus obtained was filtered, and the filtrate precipitated with a very dilute solution of acetic acid gradually added. The addition of a large amount of acetic acid at once, has to be avoided, otherwise the liquid will become so thick, as to make filtering impossible. The precipitate was washed with dilute acetic acid, and then with dilute hydrochloric acid for the purpose of washing away a trace of another proteid soluble in the latter acid; the precipitate was finally washed with water, with alcohol and ether, and at last again with absolute alcohol. Upon drying, the purified substance formed a hard yellowish mass.

3. Reactions and Composition.

The substance obtained has the following chief reactions:

It dissolves in caustic alkali of about 2%, but with difficulty, and is soluble in strong mineral acids as well as strong acetic acid.

It is not digested by artificial gastric juice, but easily by an alkaline solution of trypsin.

When concentrated sulphuric acid is added to its solution in acetic acid, it yields a fine violet coloration.

It gives the xanthoproteic and biuret reactions.

By boiling with *Millon's* reagent, it forms a red precipitate.

Tannin precipitates its solution.

Double iodide of potassium and mercury yields a turbidity.

By boiling for some time with 5% sulphuric acid, it yields not only peptone, but also a substance which reduces *Fehling* solution.

The elementary analysis was made with the purified substance, dried at 110°C. to constant weight, and yielded as average of three experiments the following numbers:—

C	52,82
H	7,53
N	14,20
O+S (calculated)	25,05
Ashes	0,41.

The determination of N was made after the method of *Kjeldahl*. The substance contains sulphur. By boiling it with caustic potash of 5%, the liquid became yellowish, and when hydrochloric acid was added in excess, sulphuretted hydrogen gas was evolved, and the paper moistened with lead acetate turned black owing to the formation of lead sulphide.

The composition of this slime is approximately the same as that of the bile (see the following table). Identity is of course doubtful, as there are many isomeric, especially stereo-isomeric mucins, possible.

	C	H	N	S	O	Ashes
Mucin of tendon[1])	48.30	6.44	11.75	0.81	——	——
Mucin of submaxillary glands[2])	48.84	6.80	12.22	0.84	——	——
Mucin of bile[3])	53.09	7.60	13.80	1.10	24.41	——
Mucinous substance of yam roots	52.82	7.53	14.20	25.04		0.41

Hammarsten declares: "Die Fähigkeit, beim Sieden mit verdünnten Säuren eine reducierende Substanz zu geben, die physicalische zähe Beschaffenheit und das Verhalten zu Essigsäure sind die drei wichtigsten Eigenschaften, welche die Mucinstoffe in qualitativer Hinsicht von dem Eiweissstoffen unterscheiden." Our slime shows all the essential characteristics of the animal mucin, and differs only in some subordinate points; it is with more difficulty soluble in dilute alkalies and yields a turbidity with potassium ferrocyanide. Our substance is doubtless a kind of mucin, and as this is the first time that such a compound has been found in the vegetable kingdom, it is certainly of physiological interest. The quantily determined as accurately as possible, amounts to 8% of the tuber dried at 100°C.

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1) *Loebisch*, Ztschr. physiol. Chem. Bd. X, S. 61.
2) *Hammarsten*, Ztschr. physiol. Chem. Bd. XII,
3) *Landwher*, Ztschr. physiol. Chem. Bd. V, S. 371.

Mannane as a Reserve Material in the Seeds of Diospyros Kaki, L.

BY

J. Ishii, *Nōgakushi.*

The fruit of *Diospyros Kaki*, L. (date-plum) is consumed in large quantities by the people of this country on account of its richness in saccharine matters. There are many varieties of the fruit, ranging in size from a small hen's egg to a large apple. In color[1] of the epidermis they vary from light orange yellow to deep orange red. My preliminary experiments proved it probable that a wine of good quality might be prepared from the fruit. It may be also mentioned here that this fruit contains, when unripe, a considerable amount of a kind of tannin which disappears entirely during the ripening of the fruit. My investigations of the *flesh* of the fruit have shown that there is a great amount of dextrose and laevulose, but neither mannose nor galactose present. It is, therefore, surprising that the *seeds* of the fruit contain no trace of starch, but a soft white mass as a reserve material, which could be easily converted into a sugar by boiling with sulphuric acid of 5% for one hour. After removal of the sulphuric acid with barium carbonate, the filtrate was evaporated, when a red-colored substance was gradually deposited; this was filtered off and the solution after being decolorized with animal charcoal was further concentrated. I obtained a sweet syrup which yielded, with acetate of phenylhydrazin in the cold, a considerable amount of crystalline precipitate, which upon recrystallization formed white tabular rhombic crystals, melting at 195°C (mannose-phenylhydrazon). By mixing a certain quantity of acetate of phenylhydrazin with the aqueous solution of the crystals and heating the mixture, there were formed gradually yellow

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1) This coloring matter is turned blue by treatment with concentrated sulphuric acid.

needles soluble with difficulty in hot alcohol and melting at 205°C. evidently phenylglucosazon. Therefore, there can be hardly any doubt that our sugar is mannose, and the white substance in the seeds a polyanhydride of mannose called mannane. It is physiologically highly interesting to see that the *seed* stores up here in the form of an anhydride a sugar that is different from the sugars contained in the *flesh* of the fruit.

Mannane as an Article of Human Food.

BY

C. Tsuji, *Nōgakushi.*

Since the discovery of mannose by *Reiss* by treating the so-called cellulose of the nut of Phytelephas with sulphuric acid, and since its closer description by *E. Fischer* who obtained it as a product of the oxidation of mannite, there have been found in many plants slime-like and cellulose-like polyanhydrides that yield by hydrolysis mannose. They have been distinguished as mannane, para-mannane and manno-cellulose.[1)]

Thus far, there is not known, however, any article of human *food* whose nutritive value is due to a polyanhydride of *mannose*, while polyanhydrides of *glucose* (starch, glycogen, maltose) play an important role, especially starch.[2)] But there are sold in this country as an article of food gelatinous colorless tablets, apparently consisting of starch paste, called *namakonniaku* that are largely consumed by the people. These tablets, however, do not give a blue coloration with iodine, and do not, therefore, consist of starch. My investigation has proved that this substance is a polyanhydride of mannose. In the following lines, I will describe the root from which the *konakonniaku* is made, and the experiments which elucidate the nature of the product.

This tuberous root-stock is derived from Amorphophallus Rivieri Durien, var, Konjac Engl., a plant belonging to the Aroideae and largely cultivated in the central part of this country. The root resembles in form the *taro*, has a white spongy flesh of a sharp taste and a brown epidermis. The root-stocks vary in size from that of a potatoe to that of a squash and reach sometimes the weight of several kilos.[3)]

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1) Compare *E. Schulze*, Z. Physiol. Chem. 16, 386.

2) The refuse of the stone-nut, used in manufacture, is utilized now in some places as a food for animals with good effect.

3) The art of preparing a suitable food from this root-stock and of removing the sharp taste was introduced into this country about a thousand years ago by Chinese.

There are prepared a powder and a gelatinous mass from the root-stock. To prepare the powder, the root-stock is sliced into thin pieces after all the skin is removed. These slices are hung up to dry, and after several weeks are ground in a mortar, and sifted.

To prepare *namakonniaku*, as the gelatinous mass is called, the powder or the root-stock is well boiled with water, then ground into a pasty mass, forced through a sieve, and transferred into a large wooden tub, mixed with an equal quantity of slaked lime and double the amount of water, and kneaded with the feet. After the mixture has become homogeneous, it is boiled with lime water until it forms a gelatinous mass.[1)]

Chemical Investigation.

The powder of *konniaku* above mentioned served principally for my experiment. It was boiled with 3% solution of sulphuric acid for several hours. On filtering a yellowish solution was obtained which was neutralized with barium carbonate, decolorised with animal charcoal, filtered, and evaporated to a syrup, from which no crystals could be obtained. It was soluble in cold water and dilute alcohol, had a strong power of reducing Fehling's solution, had a very sweet taste and turned the plane of polarization to the right. This syrup consists evidently, to a great extent, of mannose, for even a very small quantity of it at once gave in the usual way treated in the cold with solution of acetate of phenylhydrazin, a colorless crystalline precipitate soluble in hot water and hot alcohol, and thus very easily purified. The melting point of this purified precipitate was found to be 195—200C°.

There can be no doubt that this was mannose-phenylhydrazon, as this substance was easily transformed by further treatment with phenylhydrazin into phenyl-glucosazon melt-

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1) The workmen have to avoid inhaling the fine powder by covering the nose with a cloth, as the powder irritates the throat.

2) This mass is made to freeze in winter, whereby its aspect changes; this product is preferred and is called "*kōrikonniaku*."

From the root-stocks, a kind of paste is made which is principally used to increase the lustre of clothes and which is far superior to starch paste, and cheaper than the latter. Paper treated with this paste of *konniaku* is used instead of oiled paper for our umbrellas and water-proof clothes.

ing at 205°C. The characteristic mannose-oxime was also obtained by slow evaporation of a portion of the syrup with a mixture of hydrochlorate of hydroxylamine with sodium carbonate and purified by recrystallization from absolute alcohol. A portion of the sugar-syrup was also repeatedly oxidized with nitric acid to see whether mucic acid could be obtained, but none was found; therefore no galactan was present in the konniaku root-stock. Also, as no pentose reaction with hydrochloric acid and phloroglucin could be observed, there could not be present in the konniaku-root xylan or araban to any considerable extent.

If all the sugar obtained was mannose, as is very probable, then the *konniaku* powder mentioned yielded 55.86% of mannose.

This *konniaku* root is evidently very well suited for the preparation of the polyanhydride of mannose called mannane in a pure state. As this mannane is used as food, it must evidently be digested by the enzymes in the intestines and transformed into mannose or a dimannose corresponding to the maltose made from starch, but my attempts to convert the mannane of *konniaku* by diastase made from malt into a sugar, were not successful. The more interesting then is it that the human intestines can digest mannane.

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On the Scale Insect of Mulberry Trees.

(DIASPIS PATELLIFORMIS N. SP.)

BY

C. Sasaki, Rigakuhakushi,

Professor of Entomology, Agricultural College, Imperial University, Tōkyō, Japan.

WITH PLATES I.—II.

I). Description of the Mature Insects.

Male.—The body is orange red; legs, antennæ, veins of wings, balancers and anal filament yellow; head comparatively small, slightly pointed in front, where are two long and slender antennæ (Fig. 1; Fig. 1, a; Pl. I). The antennæ (Fig. 1, d) are composed of ten segments, of which the first is short, large, and stout; the second shorter and smaller than the first; the remaining eight segments are cylindrical and nearly equal in size and form, while the terminal tenth segment has a pointed end. Its length is 0,7 mm.

Eyes (ocelli) are globular, prominent, and four in number, two on the dorsal and two on the ventral side of the head (Fig. 1, b and c; Pl. I.). The dorsal pair of eyes, which lie near the lateral sides of the head, are reddish ochre brown and are surrounded by a dark brownish ring at the base. The ventral pair, which are similar in size, form, and color, to the dorsal pair, lie a little removed from the lateral margin of the head.

The thorax is ovate oblong, its anterior edge is nearly straight. The three segments—pro-, meso-, and meta-thorax—are more or less marked off from one another. The pro-thorax which is small, nearly quadrangular in form on its dorsal side, is much longer and broader on its ventral side, and its tergal face is marked with two dark orange inclined lines.

The meso-thorax which is the largest of the thoracal segments is somewhat angular in front, and rounded at the posterior end. The tergal side of the same segment is vaulted, and its scutum is marked with a dark broad reddish orange transverse

band on the anterior edge, the remaining portion with three longitudinal parallel lines. The postscutellum is small, nearly triangular in form, and there lies, between the scutum and postscutellum, a broad transverse band of dark reddish orange color. The meta-thorax which is the smallest of the thoracal segments, is wide, and closely jointed on its entire breadth with a first abdominal segment, so that it looks like one of the abdominal segments.

The fore wings, thin, membranous and transparent, are long oval, narrowed at their base. They are provided with two nervures—subcostal and cubital. The former is longer and stronger, passing parallel with the costal margin, disappears gradually towards the external margin of the wing. The cubital nervure is shorter and finer than the former, arises near the base of the subcostal nervure, and running obliquely terminates about midway of the posterior margin of the wing.

The balancer (Fig. 1, f. Pl. I) is composed of two parts nearly equal in length, of which the distal has a form of bristle with a free end slightly curved.

The legs (Fig. 1, e. Pl. I) are all of a moderate size, and almost similar in length and structure. The coxal joint is oval and stout, the trochanter which is oblong in form, is closely attached to the femur, so that these two seem to form a single spindle-shaped segment. The tibia which is somewhat more slender than the femur, is beset with a few short hairs. The tarsus is formed of only a single long piece pointed at the free end, which bears a pointed claw. The tarsus is also provided with short hairs as on the tibia. At the insertion of the claw on the tarsus, are three long club-shaped hairs.

The abdomen is nearly equal in length to the thorax, but is gradually narrowed towards its free end. It is jointed with the thorax by its entire breadth, and is composed of nine segments. The terminal segment, is provided with two long bristle-like appendages lying close side by side, so as to form a single long filament measuring 0,25 mm. in length.

The length and breadth of the body are on an average 0,80 mm. and 0,25 mm. respectively. The expansion of wings is 2,0 mm. and the caudal filament is 0,25 mm. in length (Fig. 1; 1, a. Pl. I).

Female.—The body is flattened nearly oval, light yellow in color, and covered sparsely with either club-shaped or simple hairs. It is composed of nine segments and on the lateral margins of the segments from the 3rd to the 9th, there are beset a number of long simple or 2–3 divided spines ending with an extremely fine slender filament. The dorsal surface of the body is marked by several depressions or wrinkles, and its anterior portion is broader and rounded, while the posterior is abruptly narrowed towards the free end. There is generally no demarkation between the head, thorax and abdomen, and the entire surface of the body is marked with very fine wavy striations lying very closely to each other. The lateral sides of the body are marked symmetrically with blunt processes of unequal size, which however indicate the segments of the body. The segment-lines of the body are rather hard to perceive, but on the posterior portion they become conspicuous. Besides these processes, the segments of the body are to be recognized by rows of oval figures, which lie along the boundary line of a few posterior segments. Judging from the boundary lines marked with figures, as well as the lateral processes, we may say that there are nine segments, which compose the body (Figs. 2, and 3, Pl. I).

Pygidium.—This is composed of the two last segments (8th and 9th), and is much more chitinous and hard than the remaining segments (Figs. 4, and 5, Pl. I.). The dorsal surface of the pygidium is deep orange yellow, and of an almost triangular form. Its surface is uniformly marked out with longitudinal parallel fine striations, and a little above the middle portion of this plate lies a single round opening (anus), while all over the surface are several elongated marks. On either side of the dorsal side of the pygidium, that is, on the boundary line between the 7th and 8th, and the 8th and 9th segments, there lies a row of oval figures mentioned above, which are more or less irregularly arranged one after another. These rows of oval figures are not limited to this region, but two imperfect rows of them may also be found on each of the boundary lines (dorsal) of the 5th and 6th, and the 6th and 7th segments. These oval figures secrete delicate transparent band-like materials which are used as the constituents of the scales (Fig. 4, Pl. I.). When highly magnified, these lines are more or less conspicuous by a darker

color than the remaining portion of the body. The ventral side of the pygidium is nearly similar in color, form, and nature to the dorsal. The lateral margins of the pygidium are irregularly dentated, and bear a few spines bifurcated, or divided into three short branches ending with a fine slender filament, and also a few short simple hairs. At the free narrow posterior end of the pygidium, there lie two short and wide processes arranged very close side by side. At the portion nearly anterior to one third of the ventral side of the pygidium, there lies a small genital opening. On the three sides of the genital opening, there can be seen five groups of very small polygonal or circular areas, of which one is on the anti-median portion of the opening, and the remaining four (two on each side) on the lateral portion of the same. Each of the groups is more or less oval and elongated, and they lie close to each other end to end. These polygonal or circular areas are marked on their surface with a number of minute dots. They are considered as secretory pores by Tozetti, and Franceschini[1] in the species Diaspis pentagonia, Targ., but I think in my specimen, they are not secretory pores, being simply a sort of markings (Fig. 5, Pl. I.). The antennæ (Fig. 6, Pl. I.) are two in number, and lie close at their base on the ventral side of the first segment near its free anterior edge. They are formed of a single stout broad piece, having three processes of variable size, at the base of which is beset a single long bristle (Fig. 6, Pl. I.).

The mouth parts (Fig. 7, PL. I) are modified into four long filaments (mandibles and maxillæ) which are inserted on a small process at the ventral side of the first segment of the body. They arise from one and the same point, and all of them are closely applied to each other, so as to form a single long brownish thread, whose length (1,2 mm.) is a little less than that of the body. The insect remains attached to the bark by penetrating the thread deep into the bark of the mulberry tree in order to suck the nourishment.

Anterior to the insertion of the thread, there lies a nearly triangular and somewhat concave space, which is protected on all sides by a rectangular chitinous ring which lies just beneath the skin. This concave space seems, however, to have a function similar to the sucking discs on the arms of the cuttle-fish,

in order to attach the insect-body tightly to the surface of the bark. On the front corners of the rectangular chitinous framework, lies a wide process of the same chitinous nature, while posterior to this framework is inserted the root of the four modified filamentous mouth parts. Interiorly from this root are projected two pairs of chitinous rods, of which one seems a part of modified mandibles and the other, that of modified maxillæ.

The three sides (anterior and lateral) of this concave space are somewhat swollen, and marked off from the rest of the body by a horseshoe-shaped line.

There are two pairs of spiracles (Fig. 8, a, PL. I) one on the ventral side of the first segment, and the other on the same side of the third segment of the body. The former pair open on either side of a process, on which the modified mouth-parts are inserted. They are simple oval openings measuring 0,01 mm. in longer diameter. Round this opening, except on its posterior sides, there lies a hemispherical area marked with a number of round spaces having a few fine perforations (Fig. 8, PL. I.). These perforations seem to secrete sticky filaments, which lie always in a clustre over the spiracle in the form of a white mass.

The second pair of spiracles are simple, small, and nearly circular openings, and they lie apart from each other on the ventral side of the third segment. They are smaller than those on the first segment, and measured 0,0073 mm. in diameter (Fig. 8, a. PL. I.).

The skin is pretty thick, transparent and strong, and there may be found a large number of very fine irregular transverse striations on the entire surface of the body except the pygidium, which is, on the contrary, marked with longitudinal striations. In addition to the striations, the body is covered with fine short hairs, which grow somewhat thicker near the periphery of the body.

The average length and breadh of the female insects are 1,3 mm. and 1,0 mm. respectively.

The scale which covers the female insect is more or less round, oval, and flat, bearing a slightly projecting apex nearly at the anterior third of the scale, and thus it takes the form of a patella, whence the specific name "*patélliformis*" is given. It

is pretty thick and tenaceous, but is gradually thinned out towards the peripheries. The surface of the scale is of a brownish grey color, and bears on its apex always two oval areas of orange yellow. These two areas are really two moulted skins, and the smaller lies over a portion of the larger. The former is somewhat lighter in color than the latter (Fig. 9 PL. I.). The average diameter of ten large scales is 2 mm.

II.) Manner of Copulation.

From June to the beginning of November, both sexes of the scale insects appear, the females remaining tightly attached to the bark of the mulberry tree, protected by a patella-like thick scale, which may be formed by the secretion from their bodies. The males, on the contrary, being active and provided with a pair of developed wings, can either walk or fly. When we watch carefully the scales on the bark at this season, we find that many winged males approach the scales on their wings. When the male finds the scale, the former rests quite close to the latter, and then it bends its long bristle-like genital appendages (caudal filaments) towards the margin of the scale, and projects them inwards under the scale, and copulates. Although I am unable to state exactly how the male conveys the male elements to the female, yet that such action of the male against the scale, that is, the penetration of the male genital appendages under the scale is a process of copulation, is proved by the examination of the contents of the female insects, in which there may be found a large number of actively moving spermatozoa which are received from the male. The males generally die at the end of a few days after copulation, while the females pass the winter under a scale. Thus our scale insect increases by sexual reproduction which can not be observed in Diaspis pentagonia, as Mr. Contagne has mentioned.

III.) Metamorphosis of the Scale Insects.

About March, the body of the female insects is more or less swollen by a large number of developed eggs within the body. The ovarian eggs are numerous, but the large eggs contained,

vary from a hundred to a hundred and fifty in number. The larger eggs are oblong oval, transparent, and measure 0,05 mm. and 0,025 mm. in the longer and shorter axis respectively. The light greenish contents of the eggs are easily seen through the transparent egg-shell. In May and June as well as August and September, the female insects lay eggs by projecting a temporary fleshy process from a genital opening on the ventral surface of the pygidium (Fig. 10, Pl. I.). All the eggs laid, lie usually in groups beneath the body of the mother insect under a scale. Even after the mother insects have finished depositing their eggs, they remain alive for some time. A single female deposits usually about a hundred eggs much larger than the ovarian eggs which were found in the previous spring, but they still retain an oblong and oval form, and measure now 0,247 mm. and 0,114 mm. in the longer and shorter axis respectively (Fig. 11, Pl. I.). The newly laid eggs are always pale yellow, but later as the embryo is fully developed within the egg, the latter changes from light to deep orange yellow. The larvæ are hatched some days after being deposited, and they crawl about from fissures or cracks formed at one or more places along the marginal edge of the scale. At the moment the young larvæ are hatched, the transparent thin egg-shell breaks always in one and the same way, that is, from one pole of the egg extends a breaking line as far as the median portion on two sides of the egg-shell. The newly hatched larvæ (Fig. 12; 12, a. Pl. I.) are oval flat, light orange red in color, the length and breadth of the body 0,266 mm. and 0,193 mm. respectively. The body is covered with a few fine short hairs over its entire surface, and its cuticula is marked all over with very fine wavy lines which are closely arranged side by side (Fig. 12, c. Pl. I.). The three regions of the body are not distinct, and the latter is composed of nine unequal segments, of which the anterior first segment is much larger than the last, that is the ninth segment, while both are hemispherical in form. The remaining seven segments are short, but their breadth exceeds that of the two extreme segments. The anterior first segment is marked on either side of the dorsal surface with a longitudinal slight depression. On the front of the same surface there lie two small black simple eyes lying wide apart from each other, and further

on the front edge are beset two small bristles. Anteriorly on the ventral surface of the first segment are provided two long antennæ. Each of them is composed of five segments, of which a single terminal one is nearly of the same length as that of the four remaining segments taken together. The antennal segments are provided with a few hairs, and the terminal segment with a single long hair.

The mouth parts, which are similarly modified as those of the mother insects, lie also on the ventral side of the first segment, and the position where they are inserted is marked off with a slight elevation. A filament formed of modified mouth parts lies beneath the cuticula of both thoracal and adbominal segments. It runs straight to the middle portion of the adbomen, and the running up to the first thoracal segment, turns again downwards so as to form a sort of long oval loop. The last, that is the ninth segment, is provided with two stout chitinous processes at its free end, between which are inserted two long slender bristles.

The three pairs of legs on the thoracal segment are of the same size and of similar structure. They are short and stout, the coxa and trochanter are distinct, the femur is nearly oval and the largest of all the segments, the tibia and tarsus are amalgamated into a single long segment, but the former, much reduced in size, is marked off from the tarsus by a fine transverse line. The tarsus is long, slightly widened at the free end bearing a simple claw, and the former has a slight notch just behind its free end (Fig. 12, b. Pl. I.).

The larvæ of this stage are very active, and they crawl about in every direction on stems or branches particularly in cracks. After remaining in this condition 3-4 days without taking nourishment, they undergo a first moult.

When the larvæ has ended its first moult, it grows to a size of 0,38 mm. and 0,18 mm. in length and breadth respectively, and its color becomes paler than in the previous stage. Further on, it attains 1,0 mm. in length, and undergoing a second moult, becomes either a male or female pupa.

In this larval stage (Fig. 13,14. Pl. II.), a filamentous mouth part (rostral setae) becomes free, and the larva, projecting it deep into the bark of mulberry tree to imbibe the sap, remains attached to the same spot without changing any longer its position.

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The extended rostral setae are comparatively long, measuring 0,47 mm. in length, and are yellow in color. The body is covered with sparse fine hairs, and its form as well as the antennæ, legs, the two processes and bristles on the last segment, is similar to those of the previous stage, the only difference being the increased size. The chief characteristic in this stage is the presence of two small openings (secretory pores) dorsally on the space between the two simple eyes (Fig. 13. Pl. II.). These openings lie at the end of a short chitinous tube embedded within the body, and from each of the openings, is spun out a sticky continuous silky thread which covers loosely the hinder portion of the larval body. When the threads are thus spun out, they dry up by exposure to the air, and the mucous envelope (?) of the threads is peeled off in a form of small hemispherical pieces, which present the appearance of white dust on the posterior portion of the larvæ (Fig. 15, 15, a. Pl. II.). On either side of the mouth region, that is, at the base of the secretory pores, there may be seen through the skin a concentrically coiled thread, which seems to be of the same nature as silky thread spun out of the secretory pores.

The spiracles (Fig. 14. sp. Pl. II.) are simple and small openings. One pair of them opens ventrally on the first and third segments of the body. In this stage, it seems there is still no distinction between male and female larvæ.

Some days after the larvæ have attached themselves to the bark,they moult again and change to either male or female pupæ. At the time of moulting, the skin of the larvæ splits up lengthwise on the ventral side, and there comes out a pupa, which remains still for some time beneath the moulted skin, while later the body of the pupa protrudes posteriorly from the moulted skin.

The male pupa is oval, somewhat depressed, sac-like in form, measuring 0,5 mm. and 0,3 mm. in length and breadth, and has a light greenish yellow color (Fig. 16, 16, a. Pl. II.). It has no limbs or even the rudiments of wings; but the posterior portion of the body is marked with some transverse lines showing a number of segments. The three regions of the body are not distinct. The two pairs of dark reddish brown rudimentary eyes lie near the front edge of the body, and still anteriorly on the ventral surface of the same, there is projected

a long slender rostrum, with which the pupa imbibes the sap. If we now closely examine the body, there may be found a number of small openings on the dorsal and ventral sides of each segment from the 2nd to the 9th (Fig. 16, b. Pl. II.). From these openings, are secreted very fine white filaments, which accumulate on both dorsal and ventral sides of the pupa in the form of a sac, opening at the free edge, just behind the moulted larval skin. This is the beginning of a cocoon, later it grows longer posteriorly till it becomes a perfect cocoon.

The perfectly formed cocoons (Fig. 17. Pl. II.) are snowy white, long and oval in form measuring 1,4—1,6 mm. in length and 0,4—0,5 mm. in breadth. The surface of the cocoons is usually marked with a few longitudinal ridges. They are attached to the bark of mulberry trees by their smaller end, which carries always dorsally a moulted larval skin colored greyish yellow, while the broader end is more or less elevated, and remains open free.

Some days after the pupa has been imprisoned within the cocoon, the latter bears partly an orange color, and the pupa contained within, growing now 0,67 mm. in length, is of a somewhat dark orange color. At this period of development, the body of the pupa is more or less depressed, and colored orange red (Fig. 18. Pl. II.). The three regions of the body are more or less distinct, the segments of the thorax and abdomen come into view, and the eyes are developed into a globular form of a dark brownish red color. The antennæ, wings, three pairs of legs, and a caudal appendage grow on the body in a sort of cylindrical sacs. The antennæ and wing processes lie closely attached to the lateral sides of the body. Of the three pairs of legs, the first pair is directed forwards, the remaining two pairs toward the posterior end, and a single caudal appendage lies at the end of the abdomen in the form of a blunt process (Figs. 19; 20. Pl. II.). When the pupa is so far developed, it loses its filamentous rostrum, and no longer takes sap from the bark.

The male insects are hatched twice a year, viz. in June and October, in most cases. They come out generally through the free open end of the cocoon from their posterior end; but sometimes they get rid of the anterior fixed end of the same.

After the winged insects have appeared, they remain generally near the cocoon a little while, and then crawl about the female scale, or fly in the air in order to search for the scales.

The cocoons of the male insects are generally found in groups on either stems or branches, and are particularly numerous near the base of the stem, where it is protected from the sunshine by overlying branches and leaves, and thus the cocoons give the latter a snowy white appearance in patches of variable size or at all the sides like girdles round the stems or branches (Fig. 21. PL. II.).

The groups of the cocoon are loosely covered with white continuous filaments bearing scattered white dust: these filaments are those secreted by the larvæ, and the dust is hemispherical in form. The continuous filaments are enveloped with a sort of mucous layer more or less sticky in nature, and as this layer dries up in the open air, it is thus peeled off in pieces having the appearance of small snowy white dust as mentioned before.

Female pupa.—When the mature larva fixes itself tightly with a filamentous rostrum on the bark, a scale begins to form on its posterior portion. This shows the presence of a newly formed pupa beneath the old larval skin as well as the fragmentary scale. The pupa (Fig. 22. PL. II.) is oval depressed, measures about 0,5-0,4 mm. in length and breadth respectively. The body is composed of the same number of segments as the mature female insect, and is also very similar in general aspects. The head segment bears two rudimentary antennæ, two dark brownish red eye spots, and a filamentous rostrum. The pupa with its rostrum imbibes also the sap. The abdominal segments are more or less conspicuous, and near the lateral margin and close to the boundary line between the seventh and eighth segments, as well as the free margin of the chitinous shield (pygidium) (Figs. 23; 24. PL. II.), are marked with some small oval openings at both dorsal and ventral surfaces. These openings secrete, without doubt, an extremely fine filament used as a material to form the cocoon. Further dorsally on the pygidium there opens an anus in the form of a small round opening. The free pointed end of the pygidium is provided with a pair of broad chitinous processes, and each of the lateral

margins of the same is beset with four pointed strong processes arranged at regular intervals. When a nearly circular depressed cocoon (scale) attains about 1 mm. in diameter, the pupa beneath it undergoes the last or third moult. The moulted skin which is of a dull brownish red color, becomes also part of the scale, thus the brownish red mark on a fully formed scale is nothing else than the moulted-skin of a pupa (Fig. 9. b. PL. I.).

At the moment of moulting, the pupa-skin is split up longitudinally on its ventral surface, and a female insect may come forth. Remaining in the same position, that is, exactly beneath the moult-skin, it attaches itself firmly to the bark by penetrating it with its long filamentous rostral setæ. The newly hatched female scale insects secrete also fine threads from the pores, which open on the posterior region of their bodies, and these secretions accumulate at the periphery of the already formed scale, thus increasing its dimensions. In this way the scales attain their normal size.

The scales (Fig, 21. PL. II.) are formed either in groups or are scattered sparsely over the bark of twigs or branches, and most of them, lying beneath the epidermis of the bark, present a dull greyish yellow aspect, which makes it very difficult for us to observe (especially when they lie very sparsely), owing to their color being similar to that of the bark.

As I have mentioned before, our scale insect breeds only twice a year; instead of three times, like the species Diaspis pentagonia Targ. observed by Mr. Y. Contagne.[1]

IV.) Determination of the Species of the Scale Insect.

The want of sufficient literature on the scale insect makes it very difficult to determine its exact species. But still we may say the scale insect of the mulberry trees unquestionably belongs to the genus Diaspis whose characteristics Mr. Albert C. F. Morgan[2] has described in his work "Observations on Coccidae." Its specific characters agree to a certain extent with those of the Diaspis pentagonia, Targ., which Messrs Targioni-Tozetti and Franceschini,[3] and also Mr. G. Coutagne[4] have very accurately described; but still some differences may exist between Diaspis pentagonia, Targ, and our Japanese scale

insect, in all three different stages,—larva, pupa and imago. These differences, I think, afford sufficient grounds to justify me in giving a new specific name, "patelliformis," to our scale insect.

In the following lines I will mention all the characteristics of male, female, and larva of our scale insect, which differ from those of Diaspis pentagonia, Targ. described by the above mentioned authors.

I. Male.

a. Antennæ are composed of ten segments, of which the terminal one is rather long and slender, and somewhat pointed at the free end.

b. Of the three segments of the thorax, the pro-thorax is nearly quadrangular, the meta-thorax is short and wide, and is closely jointed along its entire breadth to the first abdominal segment, and is not triangular in form.

c. The abdomen is long and conical, not elliptical.

d. The balancer is composed of two portions, the basal half club-shaped, while the distal half is reduced into the form of bristles with a hook-like end.

e. The tibia of the leg is long and cylindrical, not triangular in form. At the insertion of a claw on the tarsus, there are beset three long hairs of nearly equal length, bearing a small round head at their free end.

II. Female.

a. The body is composed of nine segments which are indicated by sutures (segment-lines) as well as by the rows of secretory pores.

b. The antennæ are formed of single broad segments with their free end divided into three pointed branches, and near the base of the antennæ there is a single long bristle.

c. One or two rows of secretory pores lie dorsally along the suture of the 5th–6th, 6th–7th, 7th–8th, and 8th–9th segments.

d. The bristles on the pygidium are either simple or divided, having on each free end a very long fine filament.

III. Larva in the first stage.

a. The body is composed of nine segments.

b. On the circumference of the body there are no depressions.

c. The antennæ are composed of five segments.

d. No particular depressions at the insertion of the antennæ.

e. The rostral setae lie beneath the skin.

IV. Larva in the second stage.

f. There are two spinnrets dorsally on the first segment of the body.

g. Dorsally and ventrally along the sutures of the posterior segments, there lie some secretory pores.

h. The rostral setae become free and unrolled.

In addition to these differences, we also notice that our scale insect copulates, and is not parthenogenetically reproduced, and the generation is effected only twice a year, not thrice as in Diaspis pentagonia, Targ.

V). Damage done by the Scale Insects, and Preventive Measures.

The scale insect is widely distributed over nearly all the provinces of Japan, where the mulberry tree is cultivated. It is not only parasitic on the mulberry trees, but may also be found in many other plantations.—such as Brousonetia papyrifera, Prunus pseudo-cerasus, Paulowina imperialis, Prunus persica, Pæonia Moutan, Sterculia plantanifolia, some species of Bambusa, &c. It frequents mostly those mulberry trees which are thickly planted, or else those which are planted in shady places, which are not directly exposed to sunshine or wind. It may be found parasitic everywhere on stems or branches of mulberry trees, but it most frequently attacks the lower parts of the stem, a few inches or rather more above the ground. The presence of the parasite as mentioned before, can easily be recognized at a certain season by a snowy white appearance on the stems or branches, which are thickly covered with the cocoons of the male scale insects. On the contrary

although the scales of the female insects remain throughout the year, they can not easily be seen on account of their dull brownish grey color, which is very similar to that of the bark on which they remain tightly attached.

When the scale insects are found parasitic in swarms or lots on stems or branches, the growth of the latter is more or less interrupted by the loss of sap, as they may be weakened to a certain extent, and particularly much more injury is done to the younger stems or shoots than to the older ones, as the former most frequently perish. Great as is the damage done by the scale insects to the mulberry trees, few owners of trees take any particular pains to destroy these formidable pests. The only method commonly practised is to scrape off the scales from the bark with small thin pieces of wood or bamboo, or sometimes with the shells of ear-shells or mussels.

The preventive methods which I consider most efficacious and most practicable for destroying this pest, is the spraying of lime water, petroleum, or a mixture of water, fish-oil, and bicarbonate of soda in the following proportion :—

1.	Water	1 litre
2.	Fish oil	32 gr.
3.	Bicarbonate of Soda	32 gr.

These preventive mixtures are more efficacious when applied in dry weather during the months of June to October; for during these months, the active young larvæ mostly distribute themselves by crawling about, or remain fixed on the bark without protection.

The method of the propagation of the insects are not as yet clearly known, but most probably it may be done during the first larval stage by the wind.

There is two natural enemies of the scale insect, one being a hymenopterous insect belonging to Chalcidæ and the other a coleoptera belonging to Coccinellidæ. Both of these decrease the number of the pest every year to a certain extent.

Tōkyō, January 1894.

LIST OF REFERENCES.

No. 1. Laboratoire d'Etudes de la Soie. 1892.

No. 2. The Entomologist's Monthly Magazine. Vol. 25.

No. 3. Bulletin de la Societé Entomologique Italienne, XXI année, 1889.

EXPLANATION OF PLATES.

All the figures are drawn by C. Sasaki, except one by the artist K. Yokoyama.

PLATE I.

Fig. 1.	Male insect.	Dorsal view.	A. oc. 1 c. *z*. j.
1, a.	,,	Ventral ,,	,,
1, b.	Head of ,,	Dorsal ,,	D. oc. 1
1, c.	,,	Ventral ,,	,,
1, d.	Antennæ of ,,		B. oc. 1
1, e.	Leg ,,		D. oc. 1
1, f.	Balancer.		,,
Fig. 2.	Female insect.	Dorsal view.	A. oc. 1
Fig. 3.	,,	Ventral ,,	,,
Fig. 4.	Pygidium.	Dorsal ,,	D. oc. 1
Fig. 5.	,,	Ventral ,,	,,

5, a. A group of circular or polygonal areas. F. oc. 3

Fig. 6. Antennæ of female insect. D. oc. 1

Fig. 7. Mouth parts of ,, ,,

Fig. 8. Spiracle on the 1st segment. F. oc. 3

8, a. spiracle on the 3rd segment. F. oc. 1

Fig. 9. Scale of female insect; a, moulted skin of larva; b, moulted skin of pupa. A. oc. 1

Fig. 10. Ovipositor projecting out on the ventral side of pygidium highly mag.

Fig. 11. Eggs. A. oc. 1

Fig. 12. Newly hatched larva. Dorsal view. D. oc. 1

12, a. ,, Ventral ,, ,,

12, b. Leg of ,, F. oc. 1

12, c. Markings on the skin of ,, ,,

PLATE II.

Fig. 13. Larva of 2nd stage. Dorsal view. D. oc. 1

Fig. 14. ,, Ventral ,, ; sp, Spiracle. D. oc. 1

Fig. 15. Silky threads spun out from secretory pores on the dorsal side.

15, a. Hemispherical pieces. F. oc. 1

Fig. 16. Earlier form of male pupa. Dorsal view. B. oc. 1

16, a. Earlier form of male pupa. Ventral view. ,,

16, b. Earlier form of male pupa, highly mag. Light spots dorsally, shaded spots ventrally opening pores.

Fig. 17. Cocoon of male insect. aa. oc. 1

Fig. 18. Cocoon with developed pupa within. A. oc. 1

Fig. 19. Male pupa. Dorsal view. B. oc. 1

Fig. 20. ,, Ventral ,, ,,

Fig. 21.	Branch of mulberry tree bearing male cocoons and female scales in masses.	$^{1}/_{1}$
Fig. 22.	Female pupa taken out of a scale. Ventral view.	B. oc. 1
Fig. 23.	Posterior portion of female pupa. Dorsal view.	D. oc. 1
Fig. 24.	Posterior portion of female pupa. Ventral view.	,,

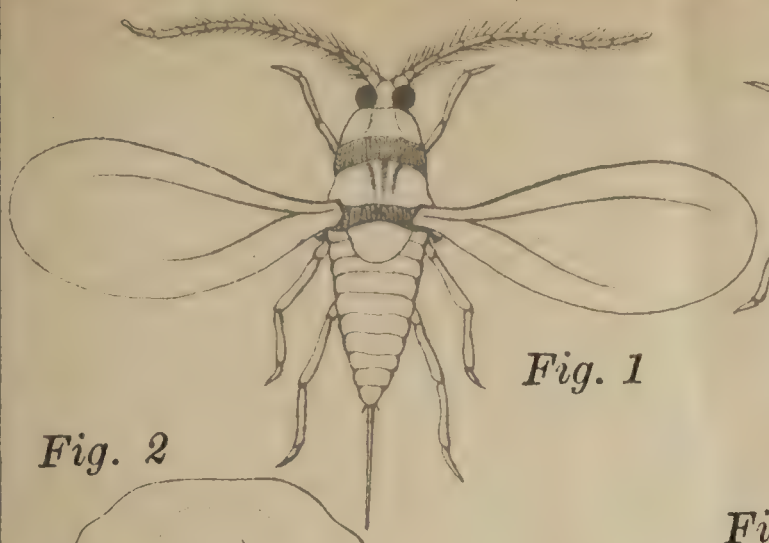


Fig. 1

Fig. 1,a

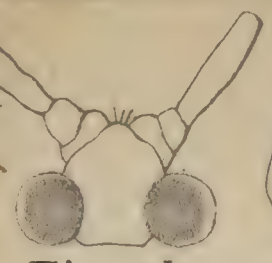


Fig. 1,b

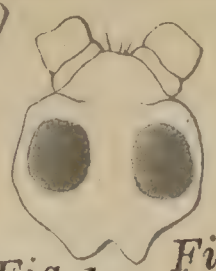


Fig. 1,c

Fig. 1,d

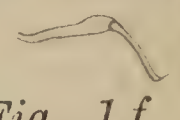


Fig. 1,f

Fig. 2

Fig. 3

Fig. 4

Fig. 11

Fig. 1,e

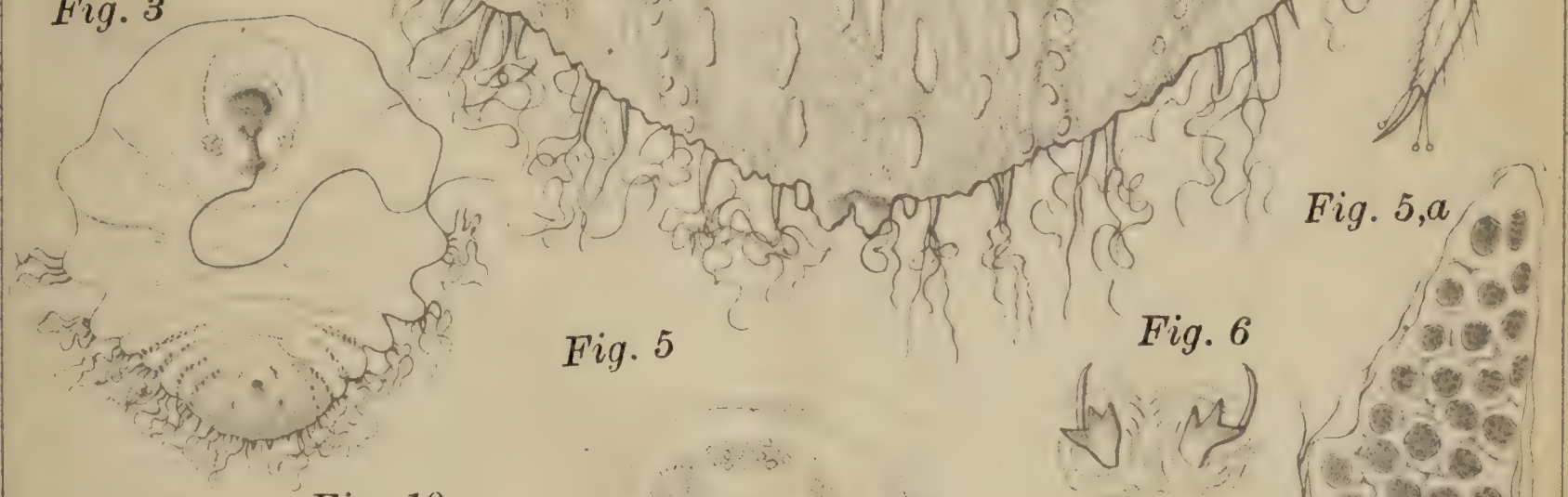


Fig. 5

Fig. 5,a

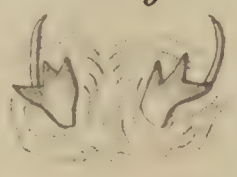


Fig. 6

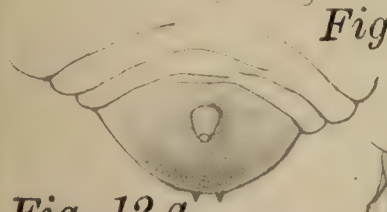
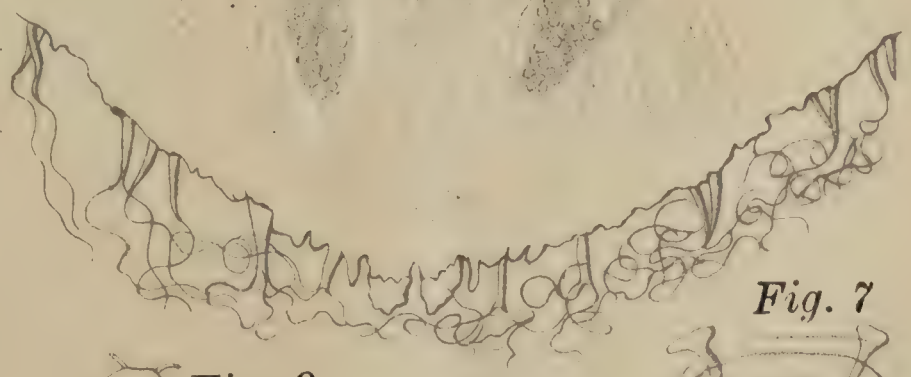


Fig. 10



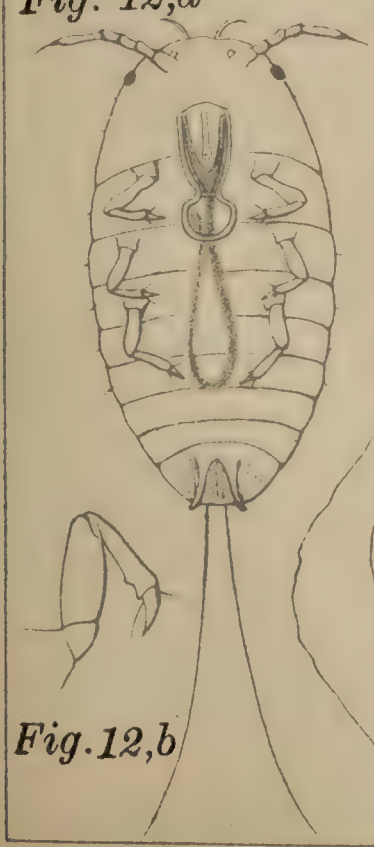


Fig. 12,a

Fig. 12,b

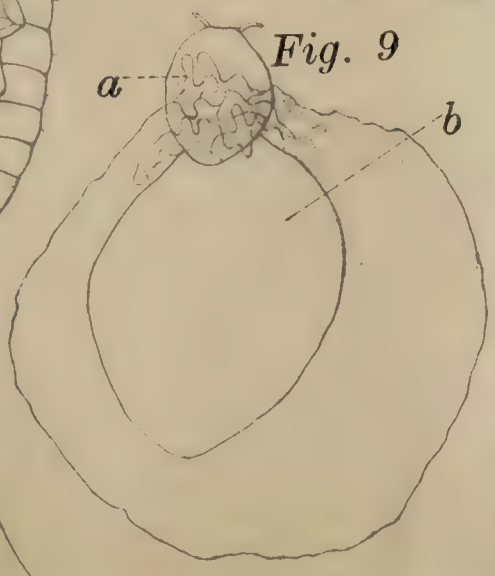


Fig. 9

a

b

Fig. 8,a

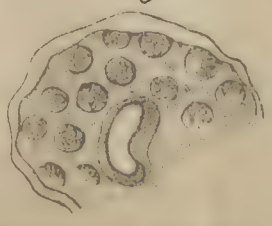


Fig. 8

Fig. 7

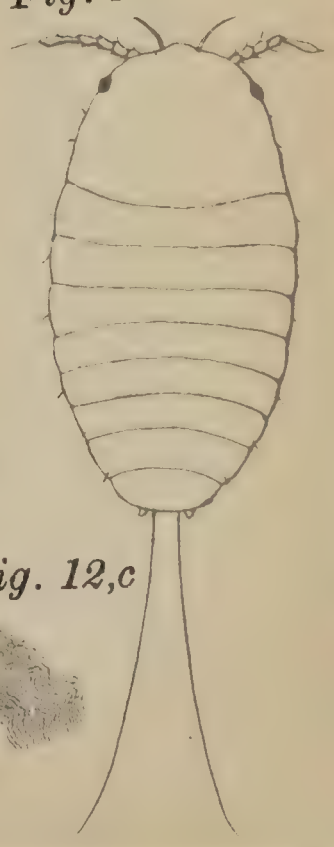


Fig. 12

Fig. 12,c

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Fig. 13

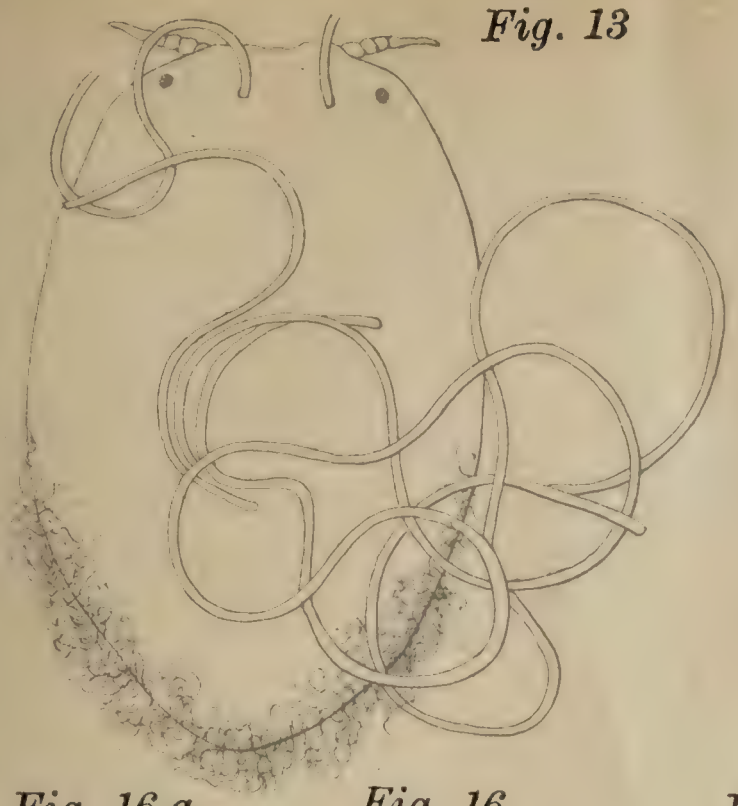


Fig. 14

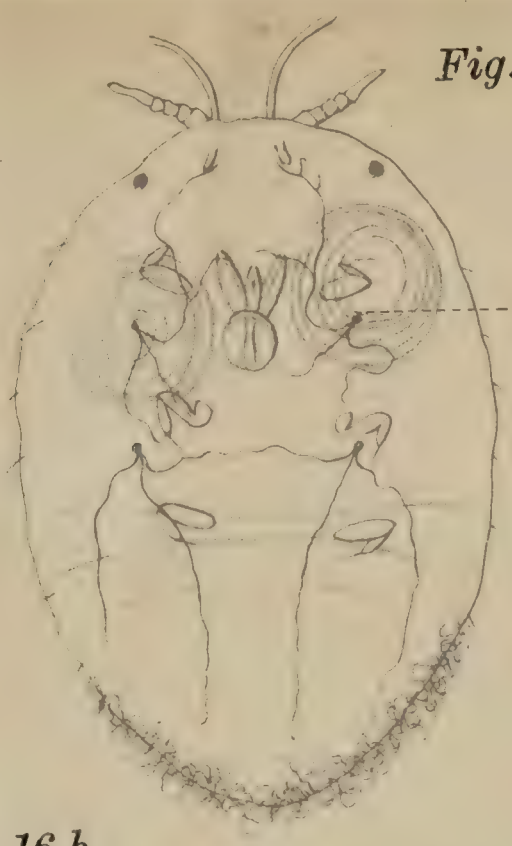


Fig. 15

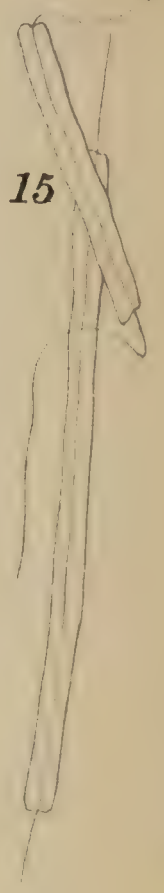


Fig. 16,a

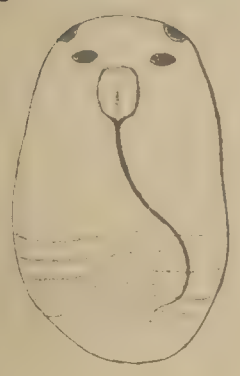


Fig. 16

Fig. 16,b

Fig. 15,a

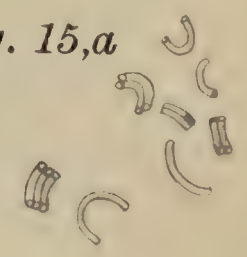


Fig. 17

Fig. 19

Fig. 18

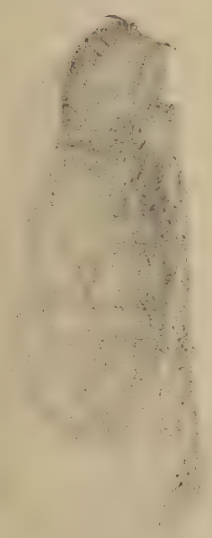


Fig. 23

Fig. 21

Fig. 20

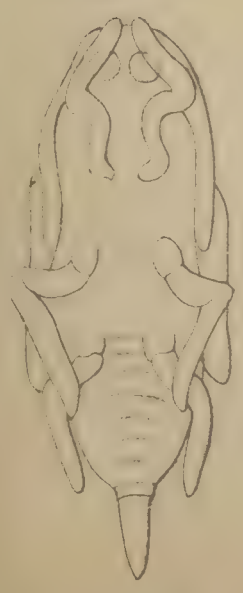
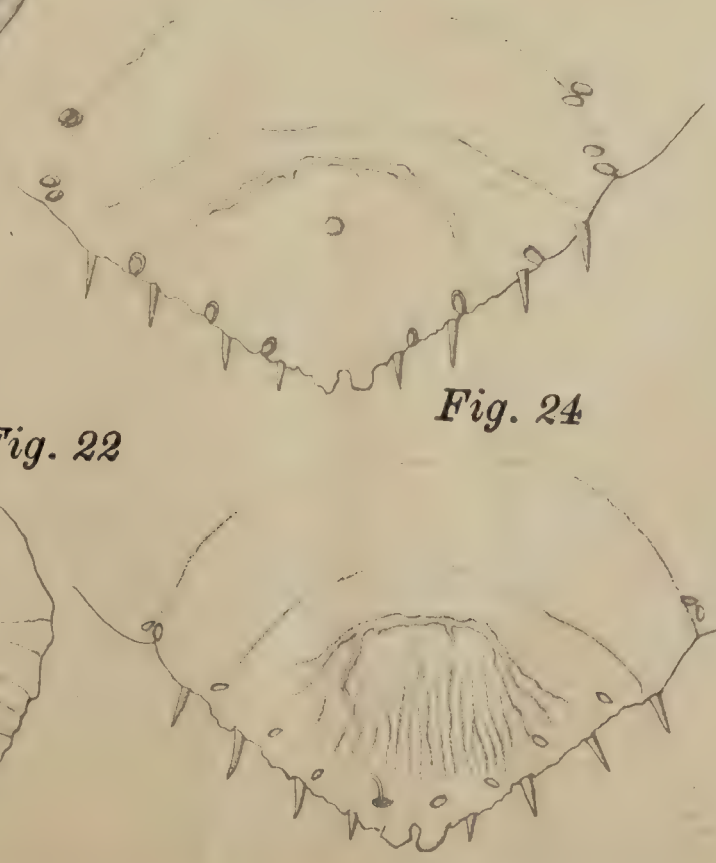


Fig. 22

Fig. 24



K. Yokoyama del.

C. Sasaki del.

On the Spermatogenesis of the Silk-Worm.[1]

BY

Kametaro Toyama, *Assistant in the Zoological Institute, Agricultural College.*

With Plates III—IV.

The work which forms the subject of the following pages was carried on in the Zoological Institute of the Agricultural College during last year. My original intention was to determine the question, whether *Verson's* large cell in the blind end of the testicular follicle is truly a genital cell or not, and in studying this I also touched upon the entire developmental history of the spermatozoa as well as the most interesting question in the development of genital cells, namely: the reduction of the chromosomes.

Before going any further, I have, in the first place, to express my sincere gratitude to Prof. *Ishikawa* for his kind guidance and friendly counsel throughout the progress of my work in his laboratory. I am also very much indebted to Prof. *Mitsukuri* of the Science College for his kindness in allowing me to use the library of the Science College, and also for various other matters. To Prof. *Sasaki* I am also much indebted for the materials. Thanks are also due to the director of the College, Prof. *Matsui* who allowed me to continue my work in the College after I passed through the university courses.

Methods of Investigation. The entire process of the spermatogenesis was studied by means of sections and teased preparations, the former method affording more advantages than the latter for the researches of the division of the genital elements.

For teasing the testicular follicles, I used acetic acid methylgreen for fixing and staining. As this causes the swelling of the chromosomes, it is very useful in calculating their number.

The following fluids are used in hardening the sections: picro-acetic acid, sublimate alcohol, salt sublimate, chromo-

(1) The preliminary note of this paper was published in the "Zoologischen Anzeiger" No. 438 this year.

formic acid, Rabl's platinum chloride, chromo-platinum chloride, 1% formic acid, and Flemming's chromo-osmium acetic acid.

Of all these Flemming's strong solution gives excellent results on fixing the nuclear elements and the cytoplasm.

For staining the nuclear elements Flemming's anilin-water safranin solution, and Hermann's triple staining is mostly employed, while the cytoplasm is best stained by Böhmer's hæmatoxylin. Most of my figures are, therefore, drawn from preparations fixed by Flemming's solution and stained by these reagents. For killing embryos 1% formic acid solution gives the best result. It not only preserves genital elements excellently, but other tissues are also very well preserved. Picro-acetic acid is not very bad, but it causes the swelling of the chromosomes, sometimes so intensely that it is impossible to calculate their number; especially the longitudinal splitting of chromosomes is utterly destroyed by its use.

For mounting sections, I used Gulland's method, as it is modified by Mr. *S. Ikeda* formerly assistant in the laboratory. This is as follows:—

A very thin and even layer of the fixative (Mayer's albumen) is painted on the slide and a little distilled water is poured upon it. The sections are then placed on the slide, the excess of the water is wiped off with blotting paper and the slide is warmed in an oven of about 30-35°C. until the water completely evaporates. After this, it is treated as usual, mounted and stained. By this method there is no need of a section-smoother, as the rolling of sections may be completely prevented and the position of sections may be changed at will while we are placing them on a slide. In Gulland's method, the same effect may be obtained, but the fixing of sections on a slide is not so strong, so that sometimes sections are removed when treated with alcohol, but in this method such a risk is avoided.

Before going into the description of the spermatogenesis, let us briefly describe the structure of the genital organs of the silk-worm in the larval stage, although the same subject has been treated of by other authors such as *Cornalia* (5), *Verson* (38, 39), and *Haberlandt* (11).

The testes are paired, kidney-shaped, and lie at the right

and the left side of the dorsal vessel over the alimentary canal, in the segment where the sixth stigmata opens (namely eighth segment) and are firmly attached to the body-wall by the trachea of the sixth stigmata and fatty tissues. As in other Lepidoptera, each testis consists of four blind tubes or testicular follicles, which are covered with a common envelope, tunica adventitia, and each is placed facing the other with the concave side, on both sides of the dorsal vessel. From the middle of the concave side of each of these testes one vas deferens arises, and the testicular follicles enter into it. These ducts run, at first, along the dorsal side of the body, gradually changing their course into the ventral side, and finally attach themselves with a uterus-shaped process (fig 3) found on the ventral median side of the twelfth segment. This process seems to be changed into seminal vesicle, accessory glands and ductus ejaculatoris.

In the female organs, all the relations are nearly similar to that of the male except the shape of the ovary and the mode of the attachment of the oviducts with it. The ovary of the silk-worm is smaller than the testis from the early beginning till to the last of the larval stage. It is somewhat triangular in shape, and is situated each side facing the other with a side of a triangle, the angles opposite to these sides being produced to form the oviducts.

This is the usual form of the genital organ of Bombyx mori in its larval stage (Fig. 1—2). Cases are, however, met with where the vas deferens arises from the outer side of the testes as in the ovary, or one of the testes with its vas deferens on its inner side and the other on the outer side.

Terminology. The question of nomenclature presents some difficulty, since so many different names have been given to the same elements by different observers. So far as I could, I have tried to avoid the use of such general terms as "spermatoblast," "spermatocyte," "spermatogone," etc. and have substituted simple descriptive expressions, as has been done by *O. Hertwig*, *C. Ishikawa*, and *vom Rath*. We may distinguish four stages in the sperm-formation of Bombyx mori. The first of which, we may call the *formative stage* ("Keimzone" of German authors), the second the *growing stage* ("Waschsthums-

periode" of German authors), the third the *ripening stage* ("Reifungsperiode") and the fourth the *stage of metamorphosis* ("Umwandlungsperiode"). The cells of the first stage will be called the *primary germ-cells* (Ursamenzellen), the cells of the second stage, the *sperm-mother-cells* after *O. Hertwig*. The cells which divide two times successively in the ripening stage, may be called the *sperm-daughter-cells*. This sperm-daughter-cell changes itself into a *spermatozoon* without further division.

The Development of the Genital Elements.

On examining a testis of a larva after the fourth moult, we are struck with the varieties of cellular elements found in it. As in the genital follicles of other Lepidoptera, the more developed elements always lie near the vas deferens, while the younger ones lie near the blind end of the follicle. In the centre of the younger elements, near the blind end of each testicular follicle, we find a large cell around which these younger elements are arranged concentrically (fig. 7).

Before passing to a description of the development of the genital elements, I shall say a few words as to the nature of this large cell in the blind end, which I shall call "*Verson's* cell." As *Verson* has already worked over the spermatogenesis of the silk-worm and described in two papers, "la spermatogenesi nel Bombyx mori; Padova, 1889," and "Zur Spermatogenesis" in the Zoologischer Anzeiger, it is necessary to quote here his opinion about this large cell. His interpretation of it, as is given in the latter of these works, is as follows:

"In jedem Fache befindet sich nur eine einzige, grosse Keimzelle; und aus dieser nehmen nach und nach alle organisirten Bildungen ihren Ursprung, aus welchen der Inhalt des ganzen Faches besteht."

Let us now see whether this interpretation of *Verson* corresponds with my observations or not.

In the embryonic stage of the silk-worm, each testis consists of only one follicle (Fig. 4) within which are scattered round cells with distinct chromosomes and a nucleolus.

It is certain that these round cells in the testicular follicle are genital cells. When the larva is about to be hatched, three depressions appear on the follicular wall. These gradually deepen until four cavities are formed. This is shown in fig. 5 *f*. Hand in hand with this change another depression appears on each of these testicular tubes as fig. 5 *i* shows, and in a testis of a larva four days old, there is seen a large cell in each of these secondary depressions of the follicle. This large cell is the origin of *Verson's* cell found in the blind end of the testicular follicle. Similar structure is also found in a testis a little younger than this, but here a distinct membrane exists between the depression and the follicular space (fig. 6), so that the depression is produced by the swelling in of one of the cells of the follicular wall, and has no connection with the genital cells lying in the follicular space. It is therefore certain that *Verson's* cell is derived from one of the follicular cells, and not from the genital cells.

This depressed cell gradually loses its membrane and produces amoeboid processes between the genital cells (fig. 11). It always has an elliptical nucleus which contains many chromatin granules (figs. 9, 10, 11, 12, 13, *v*), staining very deeply by such reagents as hæmatoxylin, carmine, and aniline dyes, and is connected with the follicular wall by a protoplasmic strand (fig. 8, p). It thus resembles very much the nucleus of follicular cells (fig. 6) which also contains many chromatin granules. Contrary to the assumption of *Verson* it has no nucleolus, nor any karyokinetic division to be found in it at any stage of its existence from the early beginning till the death of the moth. *Verson's* cell is, as stated above, generally situated in the blind end of the testicular follicle, around which the youngest sexual cells are found (fig 7 *v*). Sometimes, however, it happens to be placed at one side of the follicle (fig. 10 *v*) where more developed genital cells are found, the most interesting thing about here is that the youngest genital cells are here also found at the blind end and not around *Verson's* cell. As will be seen in fig. 10 the genital cells at the blind end of the follicle divide profusely as usual, although *Verson's* cell is not present, and this shows that *Verson's* cell has nothing to do with the formation of genital cells.

The division of *Verson's* cell takes place, as *Verson* states,

amitotically. Its nucleus becomes constricted into two or more portions producing from one to many small nuclei on the side of the large one. This mode of division is not to be seen in the first larval stages, but commencing generally at the end of it, gradually increasing to the imaginal stage (Figs. 6, 11, 9, 12, 13 *v*); but the genital elements are seen to increase in number from the first larval stages, where no division of *Verson's* cell is found.

In a testis of an imago after copulation, I have also met with *Verson's* cell, but now it does not stain so well by the reagents above described as in earlier stages (fig. 13). At this stage, there is seen a number of cells close to *Verson's* cell, probably corresponding with the cells formed by the above described amitotic division of it. These cells also take no stains and contain large vacuoles, showing thus the process of degeneration. (1)

From all this we arrive at the conclusion that *Verson's* cell is not a genital cell as *Verson* states, but it is a supporting cell connecting all the younger genital elements with the wall of the testicular follicle and probably nourishing them. This confirms the assumption of *Ziegler* and *vom Rath* (46), who says that "es erscheint eine Deutung zulässig, welche die Befunde von Verson mit denen von *vom Rath* in Uebereinstimmung bringen könnte, nämlich die Auffassung, dass die kleinen Zellen nicht die Abkömmlinge, sondern sozusagen die Geschwister der grossen Zelle (*Verson's* cell) sind und dass sie durch successive mitotische Theilung die zahlreichen Samenbildungszellen erzeugen, während der Kern der grossen Zelle, welche den Character einer Rand- oder Stütz-zelle hat, mehrfach sich amitotisch theilt."

Verson's cell may therefore be safely assumed to be a supporting cell of the testicular follicle, and is also to be seen in the blind end of an egg tube as is shown in fig. 14 and in quite young stages, it is very difficult to distinguish the male and the female elements except by the external shape of the follicle as already described.

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(1) The cells which divide amitotically in the genital follicles of the silk-worm do not belong to the cycle of sexual cells as above described and this confirms the opinion of *vom Rath* (29, II) who says that "Dem Mitosen gegenüber haben die Amitosen durchweg einen mehr oder weniger deutlich erkennbaren degenerativen Character. Die Mitose hat sich keineswegs aus der Amitose entwickelt, so dass die letztere den ursprünglicheren Theilungsmodus darstellte."

We have also met with a similar large cell in the testes of the wild silk-worm (fig. 16), Papilio xuthus L. (fig 15), P. machaon, L., P. alcinous, Klug., but not in Antherea yamamai, Guér. Mén., Caligura japonica, Moore., Rhodia fugax, Butl., etc. So it seems evident that in the genital glands of Lepidoptera, such a cell connecting the younger genital elements with the follicular wall, although not constant, is not of rare occurrence. (1)

I. *The Formative Stage.* The genital cells of this stage or the primary germ-cells, are situated near the blind end of each testicular follicle and are arranged concentrically round the supporting cell as already mentioned (figs. 7, 11). The youngest primary germ-cells are round with distinct chromosomes and nucleolus (fig. 4). When the supporting cell enters the testicular follicle and becomes connected with the genital cells, the latter assume a conical shape (figs. 11, 18), the apices of which are connected with the protoplasmic processes of the supporting cell. The nucleus of these germ-cells is always situated at the basal part of the cell, corresponding exactly to the young genital cells of Pyrrhocoris apterus described by *Henking* (15). In each follicle are seen many generations of the primary germ-cells showing the various stages of typical karyokinesis. In figs. 17-22 are represented various stages of division of primary germ-cells. Fig. 17 and 18 show cells in the resting stage; their nuclei present a spherical shape with a distinct nuclear wall. Chromatins are scattered in fine reticulum. Nucleolus is clearly to be seen in the centre of the nucleus. In a preparation fixed by the Flemming's strong chrom-osmium acetic acid solution and stained by Hermann's safranin-gentiana-orange the nucleolus is found to be suspended in the chromatin-net as one or two globules, and consists of small round chromatic bodies.

In the nucleus represented by fig. 17, is seen only a single nucleolus in the matrix of which small round granules are clearly to be seen, while in other cells (fig. 18), the

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(1) *Cholodkowsky's* (6) observation on the testis of a Diptera, also confirms the presence of such a large cell in the follicle, but it seems to be of an entirely different nature from that of the silk-worm, as it divides mitotically.

nucleolus consists of four somewhat large chromatic bodies. These chromatic bodies arrange themselves in single or double rows, or sometimes very irregularly. *Henking* (15) also pointed out a case somewhat resembling this in a nucleolus of Pyrrhocoris apterus.

When the primary germ-cells begin to divide, the fine net-work of chromosomes gradually becomes coarser (fig 19), and sometime after a beautiful skein stage is to be seen. I was not able to find, at this stage, the longitudinal splitting of the chromosomes, but this is clearly to be observed in such cells in which the nuclear segments can be distinctly made out (fig. 20).

This corresponds to the segmented skein of *Flemming*. Although the chromosomes of the primary germ-cells have divided longitudinally in this stage, they do not separate from each other until they form the equatorial plate. The double chromosomes thus formed present the appearance of being only one when viewed from one side (fig. 21). When the division proceeds a little further, the chromosomes separate from each other and go to the poles (fig. 22). Owing to the small size of the primary germ-cells, the exact number of the chromosomes can not be made out. I was, however, enabled to count, in favorable specimens, twenty-six to twenty-eight chromosomes in polar views.

The same mode of division, as now described, takes place many times in this stage, and the primary germ-cells become at last reduced to about two-thirds or less of their original size.

II. *The Growing Stage.* In the first part of this stage, the genital elements are small, in consequence of the repeated karyokinetic divisions of the primary germ-cells. I call these cells by the name of sperm-mother-cells ("Samenmutterzellen"). In the resting stage (fig. 23), the sperm-mother-cells are similar in appearance to that of the primary germ-cells. A nucleolus is generally seen in the net-work of linin and chromatin.

The sperm-mother-cells gradually enlarge, and their nuclei go through marked changes (figs. 24-46).

Most of the chromatin granules become collected to one side of the nucleus, and form an irregular mass. Fine linin

fibres with scanty chromatin granules are seen radiating from the mass to the wall of the nucleus. This is shown in figs. 24-26.

The nucleolus, lying either in the chromatin mass or outside of it, persists, as is unusual in skein stages of other animals, till to the end of the skein stage shortly to be described.

The chromatin granules once collected into a single irregular mass, become again separate from each other and arrange themselves along the radiating linin fibres, and the skein stage is thus obtained (fig. 27). In the nucleus of this stage we can easily observe *Rabl's* pole-field.

The same change of nucleus of the beginning of the growing stage was observed by *Brauer* (4) in Ascaris megalocephala where the longitudinal splitting of chromosomes was also observed. I have carefully searched after this in Bombyx, but could not find it in any of the skein stages.

The most singular thing about here is that the chromatin substances once more go through changes similar to those now described. In fig. 28 the chromosomes again have lost their even outline, and present a granular appearance. They became moreover much shorter than before. These granulations soon become more defined, and their lineal arrangement is gradually destroyed until the nucleus presents the appearance shown in figs. 28′, 29. The nucleolus, however, shows no change from the first resting stage till the present stage, and always consists of small chromatic granules imbedded in a less stainable matrix (figs. 23-29). Hand in hand with these changes of the nuclear substances, the cell-body gradually enlarges, but no metamorphosis of the cytoplasm is as yet to be recognized.

The chromatin granules scattered in the nucleus become again collected in the centre of it and present an irregular mass as before. The position of a nucleolus, or two nucleoli, is also either in the centre of the mass of the chromatin granules or outside of it in the cavity of the nucleus (fig. 30).

The same structure of the sperm-mother-cells as now described is also found in Papilio xuthus, P. alcinous, Calygura japonica, and Rodia fugax.

In a still later stage, the chromatin granules again commence to separate from one another, and the nucleus again presents the appearance shown in figs. 31 and 32. In most cases

two nucleoli are found in the nucleus of this stage, these gradually migrate towards the periphery of the nucleus facing the centre of the cyste (rarely, facing the wall of the cyste) and are finally pushed out into the cytoplasm one after the other through the nuclear wall at this point (figs. 33-38, *c*, *d*). Placed in the cytoplasm the nucleoli seem to change their quality, since they now stain differently from what they did when they were in the nucleus. This is shown by the use of Hermann's triple staining, by which the nucleolus in the cytoplasm takes a brownish colour, while it colours deep red so long as it is within the nucleus. The further fate of the nucleoli in the cytoplasm is not known.

After the disappearance of the nucleoli from the nucleus, two attraction-spheres make their appearance in the cytoplasm just at the same place where they disappeared. These two attraction-spheres gradually recede from one another until they come to the opposite poles of the nucleus. Some faint achromatic fibres are seen running between these two attraction-spheres at this time (fig. 48).

Before the extrusion of the two nucleoli from the nucleus, we can distinctly see in the cytoplasm between the nucleus and the wall of the cyste, an aggregation of microsomes (fig. 40), which in all appearance are like the "Nebenkern" described by *la Valette St. George* in a testis of Forficula auricularis (36) and others. This aggregation of cytomicrosomes has not always the same appearance in the sexual cells of the same cyste, and some of them present fibrous structures very similar to those of the achromatic spindle (figs. 36, 41-43, 47). As shown in figs. 36 and 41 this fibrous bundle is seen at first parallel to the base of a cell.

As *Henking* (15, 16) and others have already shown in other animals, all the genital cells of Bombyx mori in the same cyste are nearly in the same stage of development. Consequently we may say that the aggregation of cytomicrosomes found in one cell and the fibrous bundle in the other are two successive stages, the former changing into the latter.

The fibrous bundle, above mentioned, takes somewhat oblique position and gradually approaches the nucleus, and, when the attraction-spheres come to lie in the opposite sides of the nucleus, it connects with them forming a spindle (figs. 42, 43, 47, 49). The fibrous bundle, or the spindle, thus formed (fig. 49) consists

of three parts, the two polar parts which stain faintly with hæmatoxylin and the median part which stains deeply with the same dye.

Beside this change there is to be seen a deep colouring spot surrounded by a free area either within the cytoplasm of sperm-mother-cells or in the boundary between two such cells. It is either round or ellipsoidal in shape, and sometimes it has a constriction in its centre (fig. 33, *v*) giving it the appearance of a dumb-bell (figs. 32-37 *v*, 39-43 *v*, 47 *v*). This is surely the "Verbindungsbrücken" of *Platner* (27). Nothing can be said of its first appearance or its disappearance, but as it is found in cells in which the centrosomes are already present, it can not be the centrosome, although it appears very much like it, especially when it is found in the cytoplasm.

A little before the appearance of the centrosomes in sperm-mother-cells the chromatin granules as shown in fig. 44 gradually collect here and there and assume ring-shaped structures. These rings have already been described by *Henking* (15) and *vom Rath.* (28). Each of these rings again dissolves into four small chromatin granules (fig. 45) as *vom Rath* observed in a sperm-mother-cell of Gryllotalpa and Salamandra (28, 29). After the breaking up of the chromatin ring, the separated chromosomes are now ready to divide.

In the preparation fixed by Flemming's strong chrom-osmium acetic acid, the "Verbindungsbrücken" is clearly to be seen without any staining, while the spindle fibres can not be seen unless they are stained by hæmatoxylin. I am not able to observe these structures in the preparation fixed by picro-acetic acid and stained by picro-carmine.

In the sperm-mother-cells of the silk-worm, no accumulation of yolk granules is to be observed in the cell-body, although in other animals, such as in Ascaris and in Pyrrhocoris, this is the case.

III. *The Ripening Stage.* In this stage, we find fully grown sperm-mother-cells each of which divides two times successively and produces four cells which I will call the sperm-daughter-cells. These change themselves, without any further division, into spermatozoa.

The sperm-mother-cells with large chromatin granules and distinct centrosomes, described in the last part of the growing stage, now entirely lose their nuclear wall and the chromosomes become arranged in an equator of the spindle forming a "Kernplatte" of *Strasburger*. In this stage, I have not found any nucleolus in the "Kernplatte," while *Henking* observed it in a spermatocyte of Pyrrhocoris apterus. Fig. 50 shows a side view of this stage. The chromosomes are arranged in a single row in the equator of the spindle, and not in double rows as *Henking* (15, 16) and *vom Rath* (28) observed in genital cells of Gryllotalpa, Pyrrhocoris and Pygaera. In a polar view of "Kernplatte," we can clearly distinguish twenty-eight chromosomes (fig. 52) in most of the cells, although some with twenty-six or twenty-seven are sometimes to be found. Each of the chromosomes of the "Kernplatte," gradually produces a constriction in the middle of the long axis and forms a dumb-bell-shaped chromosome (figs. 50′, 51). This constriction deepens until two chromosomes are formed. This mode of division corresponds very well with the division of sperm-mother-cells of Diaptomus described by *Ishikawa* in the following words: "In the process of division each dumb-bell-shaped chromosome elongates and becomes divided in its middle part, so that one half of the dumb-bell goes to one pole and the other half to the other. The only difference from the ordinary karyokinesis consists in the mode of division of the chromosomes, which generally divide longitudinally and not transversely." In fig. 50′ is a "Kernplatte" of a cell in which the process of the transverse division of the chromosomes is to be seen. This is certainly an intermediate stage which is described in fig. 50 and fig. 51. After the transverse division, each row of chromosomes gradually recedes to the pole and forms a diaster stage (fig 53). This corresponds to the first reducing division of *Weismann*, each daughter nucleus containing also twenty-eight chromosomes as the mother-cells. Consequently, in this division no reduction of the number of chromosomes takes place, as *Henking* observed in the egg-and sperm-cells of many other animals (15, 16), while it corresponds very well with the first division of a sperm-mother-cell of Ascaris and Gryllotalpa described by *O. Hertwig* (18) and *vom Rath* (28).

After the division the chromosomes form a somewhat granular

mass collecting in the centre of a nucleus, but no resting stage is formed. The fate of the centrosomes is not known. The collected chromosomes gradually separate from one another and form a loose mass of chromatin granules.

A full grown spindle with a "Kernplatte" is again formed. Owing to the reduced size of the cell-body after the first division (compare figs. 51 and 52 with figs. 54 and 55 all of which are magnified to the same diameter), the spindle together with that of the individual chromosome is very small in this spindle, so that we can easily distinguish it from the spindle of the first division. A side view of a cell in this second division is shown in fig. 54. In this division, the chromosomes are arranged in a single row, and no constriction is to be seen in any of them. In the polar view of the "Kernplatte," twenty-eight chromosomes can be counted (fig. 55). These separate into two groups and form the chromosomes of sperm-daughter-cells, each of which therefore contains fourteen chromosomes. Fig. 56 represents the diaster of this stage. The exact number of the chromosomes can not be made out in the side view, but in the polar view we can clearly count fourteen (fig. 58). Sometimes, a darker structure, somewhat resembling the "Verbindungsbrücken," is to be seen under the polar spindle (fig. 57, lower figure), but I am not able to tell what this really represents.

A single or a double row of cell-plates appear at the equator of the "Verbindungsfäden" (Figs. 58, 59, 60) and the cell becomes constricted. The central and the polar spindles can now be clearly distinguished from one another (Fig 59). The former appears as a compact mass presenting a median darkly stainable part, while the polar spindle forms a somewhat semicircular ring having a centrosome in its centre.

The daughter-cells, after these changes, completely separate from each other. These we call sperm-daughter-cells which correspond with the "Spermatides" of *la Valette St. George.*

IV. *The Stage of Metamorphosis.* In this stage, the sperm-daughter-cells gradually change themselves into spermatozoa. In figs. 61 and 62 we have five sperm-daughter-cells. The "Verbindungsfäden" gradually contracts, accumulating in its end some microsomes (fig. 62 *a*, *b*). These "Verbindungsfäden" become gradually coarser, as is represented by fig. 62 *c*, *m*, and finally

change so as to form a granulated ball with a free plasm around them (fig. 62 *d*, *n*). Along with these changes, the chromosomes gradually separate from one another and arrange themselves at the periphery of the nucleus. Figs. 63 and 64 are drawn from fresh specimens treated with acetic acid methyl-green. Chromosomes collect near the nuclear wall and present a moniliform appearance in a side view. The fully grown "Nebenkern" (*n*) and mitosomes (*m*) are seen, one of the latter surrounded by a free plasm. In fig. 64 beside the "Nebenkern" and mitosomes, a row of microsomes is to be seen running through the axis of the tail. A further stage with a more elongated head and a pretty long tail is represented in figs. 65-83.

In fig. 65 is given the head of a spermatozoon at a somewhat advanced stage. Chromosomes are as in the first stage arranged at the periphery of the nucleus, while the "Nebenkern" appears more compact than before, slightly presenting its granular structure. The position of mitosomes is very irregular, being placed either below or above the "Nebenkern" (figs. 65, 66 *b*, 68, 70, 71).

Sometimes we see that it is situated at the extreme point of the head of a spermatozoon anterior to the nucleus (fig. 67 *m*).

Beside these structures there are to be seen some other granulated spots, which are sometimes coagulated into a single mass, sometimes scattered more irregularly (figs. 65, 68, 71, 72). These phenomena are very similar to those described by *Henking* in Pyrrhocoris (25). Gradually these "Nebenkern" elongate into the structure of the tail-part (figs. 68, 69, 70, 71, 72, *n*). In the cross section of the tail passing through the "Nebenkern" of this stage, radial processes are seen from the "Nebenkern" to the wall of the tail of the spermatozoa (fig. 70 *b*, 1-2).

The "Nebenkern" elongates more and more, becoming thinner, and with this change, the mitosome gradually becomes fainter and smaller. The radial processes of the "Nebenkern" disappear (figs. 73, 77). In fig. 73 a cross section of the median part of the tail with a "Nebenkern" in the centre of it, is represented.

Hand in hand with this change, chromosomes gradually accumulate at the one side of the periphery of the nucleus. This accumulation presents a somewhat crescent shaped figure, but the

individual chromosomes are still to be recognized (fig. 75 *a*, 76). An entire spermatozoon of this stage is represented in fig. 83. Here the "Nebenkern" is no more to be seen as a distinct body as before, but appears only as a thicker mass with a fine thread-like prolongation. The mitosome has also completely vanished from sight.

Figs. 78, 79 and 80 show more advanced stages. The chromosomes which are accumulated at the periphery of the nucleus became now coagulated into a single compact mass and form a deeply stainable body with a pointed end and a vacuole in the centre of it.

In fig. 82 is shown a spermatocyste with nearly matured spermatozoa contained in it. In the head part of the cyste, is seen a large cell metamorphosed from a nucleus of the cyste and functioning as a supporting cell.[1] The form of this cell is very similar to the large supporting cell in the blind end of the testicular follicle and may be compared with the cells described and figured by *Flemming* in a spermatocyste of Salamandra maculosa (9).

On the "Hodenzwischenkörperchen."

The "Hodenzwischenkörperchen" of *van Beneden* are also to be found in the genital follicles of the silk-worm of both sexes. In preparations fixed by Flemming's strong solution and stained by Hermann's triple staining very conspicuous cells are to be seen here and there (figs. 7 *h*, 84). They are round with homogeneous protoplasm, in the centre or at the periphery of which a deep stainable chromatin body, sometimes with vacuoles in it, is to be seen. Beside this, sometimes one or more small deeply stainable spots occur in the cytoplasm. In the early part of the formative stage, these cells are found in the midst of the primary germ-cells, while in later stages the entire mass of cells in a cyste presents such a structure except those at the wall of the cyste (fig. 84). They are also to be seen in the growing stage, where their structure is similar to those of the formative stage.

Sometimes the granular stainable spots in the cytoplasm

(1) This is already described by *Tichomiroff* (37).

increase in number and in the centre of them a large chromatin body is to be seen (fig. 85).

In other cells the central chromatin body is very much reduced in size, and the smaller granules increase profusely. In more advanced stages the outline of the individual "Hodenzwischenkörperchen" has disappeared and at last we see a cyste which contains only granules (fig. 86). Such cells are more abundant in a testis or an ovary attacked by Nosema bombysis than in healthy ones.

These cells are certainly similar to "globules residule" (*van Beneden*) or "Hodenzwischenkörperchen" (*O. Hertwig*) of the testes of Ascaris megalocephala. Similar cells are also described by *Hermann* and *Flemming* in the genital organ of Salamandra. These authors come to the conclusion that they are degenerating cells. The description above given confirms this view and I am quite of the opinion of *O. Hertwig* when he says (18):—"die Zwischenkörperchen nichts anderes als verkümmerte, zu Grunde gehende Hodenzellen sind."

Comparison of Verson's Observations with Mine.

As *Verson* is the only naturalist who studied the spermatogenesis of Bombyx more or less thoroughly we will here compare the results obtained by this naturalist with mine.

His description, as given in Zool. Anz., is as follows:—

"In einem bestimmten Entwicklungsstadium der Hoden schliessen sich nun an die Keimzelle die Gebilde, die sich nach einander beschreibe, in ununterbrochner Reichenfolge bis zur Spitze des Hodenfaches, wo später dieses letztere in das gemeinschaftliche vas deferens aller vier Fächer mit auswachsen wird.

"1. Die früher erwähnten Kerne haben sich aus dem Verbande mit den strahlenartigen Fortsätzen der Keimzelle losgemacht; sie erscheinen nun selbständig, und mit einem dünnen Plasmahof umgeben.

"2. Es folgen rundliche oder mehr unregelmässige Protoplasma-klumpen, welche mehrere bis zahlreiche Kerne enthalten, und da die Kerne an masse vorwiegen, so nimmt der ganze Klumpen eine Maulbeerform an.

"3. Grössere, ungefähr sphärische Klumpen, welche jedoch viel heller und an der äusseren Peripherie durch eine reinere Kreiscontour schon begrenzt erscheinen. Die Kerne sind ebenfalls hell, bläschenartig geworden, und anschliessen glänzende, scharf unschriebene, im Profil komma- oder hufeisenförmig gestaltete Körperchen.

"4. Noch grössere Blasen, an welchen eine Umhüllungsschicht und eine Inhalt unterschieden werden muss. Letzterer ist durch Kerne gegeben, die, viel zahlreicher als in No. 3, hier und dort deutlich eine schmale umgebende Plasmaschicht erkennen lassen und sich von innen epithelienartig an die Umhüllungsschicht anlegen, während gleichzeitig ein centraler Raum erscheint, welcher von geformten Elementen frei bleibt. An Grösse und sonstigem Aussehen ähnliche Kerne erblickt man auch in der Umhüllungsschicht der Blase, wenn auch spärlich vertheilt.

"5. Ähnliche Blasen wie die unter 4 beschriebenen, nur von grösserem Durchmesser. Demgemäss sind auch die einzelnen Elemente der inneren Auskleidung gewachsen, und besonders deren Protoplasma viel breiter in's Auge fallend. Die Kerne der Umhüllungsschicht sind jetzt abgeplattet, und zeigen sich im Durchschnitt spindelförmig.

"6. Ähnlich grosse Blasen mit verändertem Inhalt. Die epithelartige Lagerung der enthaltenen Zellen ist verschwunden. Letztere erscheinen mehrere Mal kleiner als in der vorhergehenden Reihe, und füllen ohne Ordnung die ganze Höhlung der Blase aus. Ihre Kerne schliessen häufig scharf markirte Kernkörperchen ein, wie jene sub. 3 angeführten.

"7. Die Blasen dehnen sich ungleichförmig und zwar nach einer einzigen Richtung aus, so dass die sphärische Form einer birn-oder schlauchartigen zu weichen beginnt. Die Umhüllungsschicht wird dabei noch dünner, und die Zellen des Inhaltes fangen im Mittelraume des Schlauches so zur zerfallen an, dass die scharf markirten Kernkörperchen frei werden, während das Protoplasma sich in länglich ausgezogene Tröpfchen auflöst. Die peripheren noch nicht zerfallenden Zellen stellen sich radiär zur Längsachse des Schlauches auf, und laufen zunächst gegen dieslbe zipfelig aus.

"8. Längliche Schläuche, an deren stumpfen, abgerundetem Ende die scharf markirten Kernkörperchen oder Derivate der-

selben sich ansammeln, während der übrige Inhalt durch länglich ausgezogene Tröpfen gegeben ist, die sich zu varicösen Fäden anreichen."

Let us now compare *Verson's* results with mine above described. The description in his first paragraph is certainly that of my primary germ-cells. The second is also primary germ-cells in their later stages. The third and fourth are the cells of the growing stage and similar to my sperm-mother-cells. The "komma- oder hufeisenförmig gestaltete Körperchen" in the nucleus are undoubtedly derived from a bad preservation of the materials, and seem to be caused by coagulation of the chromatin granules in the granular stage of the nucleus in young sperm-mother-cells. The fifth and sixth are the cells of the ripening stage. Just, as *Verson* stated, the sperm-mother-cells are generally arranged peripherally round the inner side of a cyste in a row, while after the first division such an arrangement is completely destroyed. Between the two successive divisions of the sperm-mother-cells no nucleolus appears in a nucleus. Consequently his description "ihre Kerne schliessen häufig scharf markirte Kernkörperchen ein" seems to be due to his mistaking the coagulated mass of chromosomes for the nucleolus. The seventh and eighth are the stage of metamorphosis. In this stage, he also mistakes the coagulation of the chromosomes for a nucleolus.

In general, his result agrees with that of my own investigation, though in the details it differs very much, probably in consequence of his defective methods of investigation.

Spindle Figures, "Nebenkern," Centrosomes and Nucleolus.

As to the origin of the achromatic spindle, many facts have been observed by eminent naturalists such as *van Beneden*, (1) *Flemming* (7), *O. Hertwig* (19), *Platner* (25), *Strasburger* (33, 34), *Hermann* (17), *Boveri* (2), *Brauer* (4), *Waldyer* (40), *Rabl*, (29) *Watase* (41) *Schewiakoff* (3), *Ishikawa* (21, 22) and many others, in different animals and plants. In general, there are, as far as my knowledge goes, three views as to its origin: (1) the achromatic threads arise chiefly from the cell protoplasm; (2) they

arise from the achromatic thread substance of the nucleus; (3) they arise both from the achromatic nuclear constituents and from the cytoplasm. *O. Hertwig* states in his celebrated text book "Die Zelle und die Gewebe" that, "Ich have früher den Standpunkt vertreten und nehme ihn auch jetzt noch ein, dass, abgesehen von den Polstrahlungen, die dem Protoplasmakörper der Zelle angehören, die verschiedenen Structurtheile der Kernfigur von den einzelnen Substanzen des ruhenden Kerns abstammen. Die stoffliche Grundlage für die Spindel und die später aus ihr hervorgehenden Verbindungsfäden suche ich in dem Liningerüst."

In the sperm-mother-cells of Bombyx mori, it seems to be a clear fact that the central spindle is derived from the cytoplasm as will be seen in figs. 40, 41, 42, 43, 47, and 49. Of the polar parts of the achromatic spindle, I am strongly inclined to believe that they are derived from the nucleus, because at the time when the central spindle is formed in the cytoplasm (figs. 36, 41, 42 and 43), both the centrosome and radial fibres are as yet not to be seen. When centrosomes appear at the two poles of the spindle, the radiating fibres come distinctly into view (fig. 49).

Let us now consider the origin of centrosomes. After the discovery of this body by *E. van Beneden* in Ascaris megalocephala, *Flemming* (8), *Guignard* (10), *Strasburger* (34), *Heidenhein* (13) *vom Rath* (29) and others have shown that they are present in the cytoplasm also during the resting stage of the nucleus. I have also found a distinct centrosome with a well developed archoplasm in the resting sperm-mother-cells of Panulirus japonicus (figs, 87, 88, 89 and 90), but in the sperm-mother-cells of Bombyx mori, I am unable to detect the centrosome in the resting stage.

Watase (42) considers the centrosome as an aggregation o the cytomicrosomes, and states that "for the centre of the aster is the point where the greatest number of cytoplasmic filaments meet with one another and the size of microsomes produced at such a place must be correspondingly large. In other words, the microsome produced in the centre of the aster is the centrosome[1])." *A. Brauer* (3, 4) discovered the formation of

1) *Schneiders's* observation is little different from *Watase's*. He states that the attractions—spheres consist of a convolution of thin threads, and the radiated threads form the "Polsonne."

centrosome from a nuclear matter and states in his beautiful work recently published "Zur Kenntniss der Spermatogenese von Ascaris megalocephala," that "in dem einen Falle, bei Univalens, tritt das Centrosom in Kerne auf, wächst und theilt sich hier, und die Hälften rücken dann nach zwei einander entgegengesetzten Punkten auseinander und treten durch Lücken der Membran in das Protoplasma über, die Spindelfasern gehen aus den Fasern hervor, welche vom Auftreten des Centrosomes an letzteres und das Chromosom verbinden, die Spindel ist mithin in allen ihren Theilen eine einheitliche Bildung, sie besteht nur aus Kernsubstanz[1]."

In the testes of Bombyx mori as above stated the extruded nucleoli are probably the origin of the centrosome. Although I was not able to see exactly as *Brauer* did in the testes of Ascaris, I can not help thinking that there must be some genetic connection between these two bodies, there being such an exact correspondence in the time and the place of the disappearance of the nucleolus and the centrosome. The only difference between them being the size, which is much greater in the nucleolus than in the centrosome. This, however, is probably caused by the formation of the polar spindle from a part of the nucleolus. If this is proved, then the central spindle is derived from the cytoplasm and the polar spindle from the nucleus.

In the structure of the spindle, my results are entirely similar to those of *Hermann* who says: "an der fertig ausgebildeten Spindel wird dieser Theil die axiale Mitte derselben einnehmen, weshalb ich ihn mit dem Namen Centralspindel belegen möchte und wird aus Fibrillen bestehen müssen, die direct und continuirlich von Polkörperchen zu Polkörperchen ziehen, ohne auf ihrem Wege überhaupt mit chromatischen Kernelementen in Beziehung zu treten. Gewissermassen als Mantel werden sich über diese Centralspindel jene Fasersysteme herüberlegen, die von den beiden Centrosomen aus zur Herbeiholung der Chromatinelemente entsendet wurden, und diese Fibrillenzüge

1) *Wasielewski* (43) also states the relation between centrosome and nucleus in the genital cells of Ascaris megalocephala, while *Karsten* (23) has observed the extrusion of nucleolus from a nucleus to form centrosome in cells of plants (Sporangium of Psilotam).

können nicht von Pol zu Pol ziehen, sondern werden in der Nähe des Spindeläquators durch ihren Ansatz an die sich färbenden Kernbestandtheile eine Unterbrechnung erleiden müssen."

The "Nebenkern" is according to *la Vallette* derived from cytomicrosomes, where he says (35) "hier wie dort ganz unzweifelhaft seine Entstehung aus dem körnigen Zellplasma zu constatieren," while *Platner* (26) assigns its origin to the nucleus. On this point he says: "Hier entwickelt sich aus dem Kern ein eigenthümliches, an frischen Preparaten glänzendes, durch dunkleres Aussehen und homogene Beschaffenheit von dem umgebenden Protoplasma sich unterscheidendes Element. Es ist der Nebenkern in seiner ersten Anlage." Beside this he (27) describes in the cytoplasm of the spermatocytes of Lepidoptera, a structure which he designates by the name of "Verbindungsbrücken."

In the sperm-mother-cells of the silk-worm, we also find a body which has the same appearance as both *Platner's* "Verbindungsbrücken" and his centrosome. As it is present in the cytoplasm even after the appearance of two centrosomes, it is not a centrosome, so I will call it the "Verbindungsbrücken" after *Platner*, although this body is sometimes found within the cell and not always between the two neighbouring cells. It is a round body surrounded by a free plasm and staining very deeply by methylen-blue or Böhmer's hæmatoxylin. There is generally only one but sometimes two. Rarely it has a constriction forming a dumb-bell-shaped rod. When it is present in the cytoplasm, it corresponds very well with the centrosome of *Platner* (25) who observed it in many Lepidoptera (cf. his figs. 3, 4, 5). After the complete formation of the spindle, it dissolves and is no more to be seen. Up to the present the function of this body is quite obscure and requires further investigations.

Besides the "Verbindungsbrücken" we observe in the cytoplasm an aggregated spot of microsomes which afterwards changes into the central spindle. It resembles very much in shape the "Nebenkern" of *la Valette* (35, 36) and originates also from the cytomicrosomes. *Hermann* (17), *Solger* (32), *Platner* (25) *Ishikawa* (22) and others consider the "Nebenkern" to be a centrosome with archoplasm. This seems to be the case in Panulirus japonicus referred to above. But the structure known

as the "Nebenkern" appears not always to be a centrosome surrounded by an archoplasm, as the "Nebenkern" of the silk-worm above described, shows very plainly. The formation of the "Nebenkern" of the sperm-daughter-cell from the "Verbindungsfäden" of the sperm-mother-cell in the silk-worm confirms the opinion of *Hermann* who describes it in the spermatocyte of Salamandra in the following words (17): "unleugbar dem Protoplasma entstammend, kehren die Fibrillen der Centralspindel bei Rekonstruction der Tochterkerne, radienartig ausstrahlend, wieder in das Protoplasma zurück."

On the Reduction of Chromosomes.

Since the theoretical consideration of *Weismann* (44), the reduction of chromosomes in sperm-mother-cells has been confirmed by many eminent authors such as *Flemming* (8), *Hæcker* (12), *Henking* (14, 75, 16), *O. Hertwig* (18), *Ishikawa* (20) *Platner* (15, 27), and *vom Rath* (28, 29), in many animals. Especially by the beautiful researches of *O. Hertwig's* "Vergleich der Ei und Samenbildung bei Nematoden" not only is this fact proved but also the similarity of the development in both sperm- and egg-cells has become clearly known. In general, our researches on the spermatogenesis of Bombyx mori corresponds so exactly with the descriptions given by these authors, that it seems almost superfluous for me to publish them. I have deemed it, however, worth while to record the results of my own investigations because there are some points of controversy among the conclusions arrived at by these authors. As the ground of this question we will quote the researches of *O. Hertwig* on the Nematodes. His summary is:

"1. Die Samenmutterzelle entspricht der Eimutterzelle oder dem unreifen Ei.

"2. Während des länger dauernden Ruhezustandes des ansehnlichen bläschenförmigen Kerns der beiden Geschlechtsproducte wird die Kernsubstanz gleich für zwei Zelltheilungen, die sich unmittelbar aufeinander folgen, in eigenartiger Weise vorbereitet.

"3. Die im Keimbläschen und in dem Samenmutterkern vorbereitete Menge wirksamer Kernsubstanz ist gleich gross, wie in jedem andern Kern vor der Theilung. Eine Reduction durch Ausstossung oder Rückbildung hat nicht stattgefunden.

"4. Während der zwei sich unmittelbar aufeinander folgenden Theilungen findet eine Vermehrung der Kernsubstanz nicht statt, da das bläschenförmige Ruhestaduim des Kerns ausfällt, und da die im Keimbläschen und Samenmutterkern vorbereiteten chromatischen Elemente während der zwei Theilprocesse weder an Masse zunehmen, noch sich der Länge nach spalten. Die aus dem zweiten Theilungsact hervorgehenden Endproducte enthalten daher in Folge der zweimal eingetretenen Halbirung nur die Hälfte der Kernmasse, welche ein gewöhnlicher Kern nach der einfachen Theilung besitzt.

"5. Die Anzahl der im Samenmutterkern und Keimbläschen vorbreiteten chromatischen Elemente ist bei Ascaris ebenso gross, wie bei einem gewöhnlichen Kerne in der Mitte des Theilungsprocesses, also die doppelte wie sie ein Kern in der Vorphase der Theilung zeigt. Der morphologische Werth dieser Elemente scheint aber ein anderer zu sein, in Folge einer von normalen Verlauf abweichenden Entstehung. Während normaler Weise acht Tochterchromosomen durch einfache Längsspaltung von vier Fäden entstehen, scheinen sie hier durch doppelte Längsspaltung von nur zwei Fäden gebildet worden zu sein. Diese zwei Fäden enthalten aber dieselbe Substanzmenge, wie vier durch Quertheilung am Anfang der Karyokinese gebildete Fäden.

"6. Da die Eimutterzelle und die Samenmutterzelle dieselben Kerntheilungsprocesse mit allen ihren von der Norm abweichenden Eigenthümlichkeiten in genau der gleichen Weise durchmachen, müssen die Theilproducte auch denselben morphologischen Werth besitzen.

"a) Den beiden Samenmutterzellen entsprechen Ei-und erster Richtuugskörper.

"b) Den vier Samenenkelzellen (Samenkörpern) sind das reife Ei, der zweite Richtungskörper und die aus Theilung des ersten Richtungskörpers entstehenden zwei Kügelchen zu vergleichen.

"c) Die Richtungskörper haben daher den morphologischen Werth rudimentärer Eizellen."

The investigations of *vom Rath* (28) on the spermatogenesis of Gryllotalpa and of *Hæcker* (12) on the egg-formation of Cyclops and Canthocamptus, correspond very well with *Hertwig's* results, and *Weismann* summarises the facts in the following words: "In all those species which have been investigated for this purpose, the germ-cells are formed by the mother-cell undergoing two consecutive divisions, each of which results in a halving of the number of idants, one half passing into the one daughter-cell, and the other half into the other. In the second division this would lead to the presence of only a quarter of the original number of idants, if the number in the mother-cell were not doubled by each idant becoming split into two before the first division takes place. Thus there is first a doubling, and then a halving, of the number of idants. I consider this remarkable and apparently useless process of the doubling and two subsequent halvings of the idants as a method of still further increasing the number of possible combinations of idants in the germ-cell of one and the same individual, and have given reasons for this opinion in the above named essay."

Prof. *Ishikawa's* results on the reproductive elements of Diaptomus sp. also correspond with the results of the above named authors except the mode of division, in which he describes the transverse constriction of the chromosomes in the first division of the sperm-mother-cells giving rise to dumb-bell-shaped bodies.

Henking's researches on the genital elements of many insects (16, 15) are different from the results of all the above named authors, in the time of the reduction of chromosomes. According to this author the reduction of chromosomes takes place in the first division of the spermatocytes or sperm-mother-cells and no doubling of chromosomes takes place in the growing stage of these cells, while their second division is to be looked upon as the "Equationstheilung."

In Bombyx mori, as stated above, twently-eight chromosomes are found in the primary germ-cells. In the growing stage I could not detect any longitudinal splitting or the doubling of the number of chromosomes as *vom Rath* gives it in the sperm-mother-cells of Gryllotalpa (28). Here I am more inclined to agree with *Henking* (15) who denies its occurrence.

In the first division of the sperm-mother-cells ("Spermatocyten 1. Ordn."), the twenty-eight chromosomes in the equatorial plane of the spindle divide transversely, as stated above, and produce two rows. Both *Henking* and *vom Rath* affirm also the existence of two rows of chromosomes in the equator of the spindle of this stage. But this, according to *vom Rath* (28), is due to the doubling of the chromosomes in the growing stage of the sperm-mother-cells, while *Henking* (15) believes it to be formed by the double arrangement of the chromosomes, already existing, so that according to this latter author, the reduction of the number of chromosomes takes place by this division, which according to all other authors occurs by the second [1].

The reduction of the number of chromosomes in the genital cells of plants has been worked over, so far as I know, only by *Guignard* (10). The mode of the reduction which he observed of Lilium martagon, however, differs entirely from that of animals. According to this investigator the reduction occurs without a nuclear division in a stage of the "cellules mère définisives" (probably corresponding to the sperm-mother-cells of animals). My investigation on the formation of the pollens of Lilium tigrinum and Allium fistulosum is not in accordance with this, but shows much similarity with that of animals. This I trust will be soon published.

Summary.

1. A large cell in the blind end of the follicle which is designated by the name of "Keimzelle" by *Verson*, is not a genital cell but a supporting cell which connects the genital cells with the follicular wall. It always has a large nucleus with finely granular chromosomes collected here and there and staining very deeply with hæmatoxylin, safranin, carmine, and anilin colours.

(1) According to the investigations of *Moore* (24), the sperm-mother-cells of the rat contain sixteen chromosomes, which are reduced into eight, and "the reduction would appear more comparable to the type described by *Guignard* during the formation of vegerable pollen, than, to that pointed out by *Hertwig* in the spermatocytes of Ascaris." This however appears to me very improvable.

2. The primary sperm-cell resembles very much the primary egg-cell, and is conical in shape and contains a nucleus in its broad end. Its nucleolus always consists of an aggregation of chromatin granules, whose number varies from two to four or more. It divides many times in the usual karyokinetic manner, and the cell-body gradually decreases in size until it becomes about two-thirds or less of the original cell. It is then called the sperm-mother-cell and passes to the growing stage.

3. In the early part of the growing stage, the sperm-mother-cell has an ordinary resting nucleus with the chromatin granules scattered in it. It gradually becomes larger, and with this the change of nucleus takes place. The chromatin granules first gather themselves to one side of the nucleus and form an irregular mass from which fine achromatic fibres radiate. This chromatin mass dissolves and a fine skein stage with a nucleolus is formed. The chromatin granules of this skein again dissolve into many isolated granules and the nucleus again assumes a granular structure. There are now two nucleoli in each nucleus. These nucleoli pass out into the cytoplasm one after the other. An achromatic spindle is also seen at this stage, formed from cytomicrosomes. This spindle consists of two parts, the central and the polar, which latter seems to be derived from the nucleus together with the centrosomes. The granular chromosomes, now again collect themselves and form ring-like structures. Each of these rings dissolves again into four chromosomes and forms "Kernplatte."

4. The sperm-mother-cells contain at first twenty-eight chromosomes. In the first division each of these divides transversely to its long axis and forms two chromosomes, of which one goes to one pole and the other to the opposite pole. The daughter-cells thus contain each twenty-eight chromosomes as the mother-cell.

The nuclei of these daughter-cells form no resting stage, and directly pass over to the second division in which half the number of chromosomes goes to one cell and the other half to the other. The grand-daughter-cells thus formed contain therefore only fourteen chromosomes, which is half the number of the mother-cell.

5. After this division, the fourteen chromosomes collect at

the periphery of the nucleus and finally form a compact, deeply stainable mass with pointed end and vacuole. This chromatin mass gradually elongates and forms a spindle-shaped head of a spermatozoon. From the remnants of the "Verbindungsfäden," a "Nebenkern" is formed, which elongates and enters into the tail part. A mitosome is also seen, arising from the cytomicrosomes.

End of December, 1893.

LIST OF WORKS REFERRED TO.

1. Van Beneden, Ed.—Recherches sur la maturation de l'oeuf et la fécondation. Arch. d. Biologie. T. IV. 1883.
2. Boveri, Th.—Zellen-Studien. Heft 2. Jena. 1888.
3. Brauer, A.—Zur Kenntniss der Herkunft des Centrosomas. Biol. Centralbl. Bd. XIII. 1893.
4. Brauer, A.—Zur Kenntniss der Spermatogenese von Ascaris megalocephala. Arch. f. mikr. Anatomie. Bd. XXXXII. 1893.
5. Cornalia, E.—Monographia del bombice del gelso. 1856.
6. Cholodkowsky, N.—Zur Kenntniss der männlichen Geschlechtsorgane der Dipteren. Zool. Anzeiger. 1892.
7. Flemming, W.—Neue Beiträge zur Kenntniss der Zelle. Arch. f. mikr. Anatomie. Bd. XXIX. 1887.
8. Flemming, W.—Neue Beiträge zur Kenntniss der Zelle. II. Arch. f. mikr. Anatomie. Bd. XXXVII. 1891.
9. Flemming, W.—Weitere Beobachtungen über die Entwicklung der Spermatosomen bei Salamandra maculosa. Arch. f. mikr. Anatomie. Bd. XXXI.
10. Guignard, L.—Nouvelles études sur la fécondation. Ann. Sc. Natur., Botanique. T. XIV. 1891.
11. Haberlandt, F.—Der Seidenspinner des Maulbeerbaumes. Wien. 1871.
12. Haecker, V.—Die Eibildung bei Cyclops und Canthocamptus. Zoolog. Jahrbücher. Bd. V. Abth. f. Morph. 1891.
13. Heidenhain, M.—Über Kern und Protoplasma. Festschr. f. Prof. von Kölliker. 1892.
14. Henking, H.—Über Reduktionstheilung der Chromosomen in den Samenzellen von Insekten. Internat. Monatsschr. f. Anat. u. Physiol. Bd. VII. 1890.
15. Henking, H.—Untersuchungen über die ersten Entwicklungsvorgänge in den Eiern der Insekten. II. Über Spermatogenese und deren Beziehung zur Eientwicklung bei Pyrrhocoris apterus, L. Zeitschr. f. wiss. Zoologie. Bd. LI. 1891.
16. Henking, H.—The same. III. Specielles und Allgemeines. Zeitschr. f. wiss. Zoologie. Bd. LIV. 1893.
17. Hermann, F.—Beiträge zur Lehre von der Entstehung der karyokinetischen Spindel. Arch. f. mikr. Anat. Bd. XXXVII.
18. Hertwig, O.—Vergleich der Ei- und Samenbildung bei Nematoden. Arch. f. mikr. Anat. Bd. XXXVI. 1890.
19. Hertwig, O.—Die Zelle und die Gewebe. Jena. 1893.
20. Ishikawa, C.—Studies of reproductive elements. I. Spermatogenesis, ovogenesis and fertilization in Diaptomus. Jour. of the Coll. of science. Imp. Univ. Japan. Vol. V. 1891.
21. Ishikawa, C.—The same. II. Noctiluca miliaris, Sur.; its division and sporeformation. Jour. of the Coll. of Science. Vol. VI. 1894.
22. Ishikawa, C.—Über die Kerntheilung bei Noctiluca miliaris. Bericht. d. naturf. Gesellschaft z. Freiburg. Bd. VIII. 1893.

23. Karsten, G.—Über Beziehungen der Nucleolen zu den Centrosomen bei Psilotum triquetrum. Bericht d. Deuts. Bot. Gesellschaft. 1893.
24. Moore, J. E. S.—Mammalian Spermatogenesis. Anat. Anzeiger. 1893.
25. Platner, G.—Beiträge zur Kenntniss der Zelle und ihrer Theilungserscheinungen. Arch. f. mikr. Anat. Bd. XXXIII. 1889.
26. Platner, G.—Über die Entstehung des Nebenkerns und seine Beziehung zur Kerntheilung. Arch. f. mikr. Anat. Bd. XXVI. 1886.
27. Platner, G.—Die Karyokinese bei den Lepidopteren als Grundlage für eine Theorie der Zelltheilung. Inter. Monatschr. f. Anat. u. Histol. Bd. III. 1886.
28. Vom Rath, O.—Zur Kenntniss der Spermatogenese von Gryllotalpa vulgaris Latr.. Arch. f. mikr. Anat. Bd. XL. 1892.
29. Vom Rath, O.—Beiträge zur Kenntniss der Spermatogenese von Salamandra maculosa. I. Theil. Die Reduktionsfrage. II. Theil. Die Bedeutung der Amitose in Sexualzellen und ihr Vorkommen im Genitalapparat von Salamandra maculosa. Zeitschr. f. wiss. Zoologie. Bd. LVII. 1893.
30. Rabl, C.—Über Zelltheilung. Morphol. Jahrbuch. Bd. X. 1885.
31. Schewiakoff, W.—Über die Karyokinetische Kerntheilung der Euglypha alveolata. Morphol. Jahrb. Bd. XIII. 1888.
32. Solger, B.—Zelle und Zellkern. Thiermed. Vorträge. Bd. III. 1892.
33. Strasburger, Ed.—Histologische Beiträge. Heft. 1. Über Kern- und Zelltheilung im Pflanzenreiche etc. Jena. 1888.
34. Strasburger, Ed.—The same. Heft. IV. Schwärmsporen, Gameten, pflanzliche Spermatozoiden, und, das Wesen der Befruchtung. Jena. 1892.
35. St. George, von la Valette.—Spermatologische Beiträge. Heft II. Arch. f. mikr. Anat. Bd. XXVII. 1886.
36. St. George, von la Valette.—Zelltheilung und Samenbildung bei Forficula auricularia. Festschr. f. von Kölliker. 1887.
37. Tichomiroff, A.—Entwicklungsgeschichte von Bombyx mori L. im Ei (*Russ.*) Moskau. 1882.
38. Verson, E.—La spermatogenesi nel Bombyx mori, L. Padova. 1889.
39. Verson, E.—Zur Spermatogenesis. Zoolog. Anzeiger. Jahrg. XII. 1889.
40. Waldeyer, W.—Über Karyokinese und ihre Beziehungen zu den Befruchtungsvorgängen. Arch. f. mikr. Anat. Bd. XXXII. 1888.
41. Watase, S.—Karyokinesis and the cleavage of the ovum. Johns Hopkins University Circulars. Vol. IX. 1890.
42. Watase, S.—Homology of Centrosome. Jour. of Molphol. Vol. VIII. 1893.
43. Von Wasielewski.—Die Keimzone in den Genitalschläuchen von Ascaris megalocephala. Arch. f. mikr. Anat. Bd. XXXXI. 1892.
44. Weismann, A.—Essays upon heredity and kindred biological problems. Vol. I. Oxfold. 1891.
45. Weismann, A.—The Germ-plasm. (English translation of "Keimplasma"). London. 1893.
46. Ziegler, H. E., und vom Rath, O.—Die amitotische Kerntheilung bei den Arthropoden. Biolog. Centralblatt. Bd. XI. 1891.

EXPLANATION OF PLATES, III—IV.

All figures are drawn with Abbe's camera lucida as well as drawing prism. Objectives and oculars used, are mentioned with explantions of figures.

Fig. 1. Surface view of male sexual organ of larva two days old. Killed with picro-acetic acid and stained with alcohol carmine. (*t*) testis, (*d*) dorsal vessel. (Zeiss, Obj. D, Oc. I).

Fig. 2. Surface view of female sexual organ of larva two days old. Similarly treated as above. (*o*) ovary, (*d*) dorsal vessel. (Zeiss, Obj. D, Oc. I).

Fig. 3. Terminal portion of vas deferens of larva in fifth stage. (*m*) muscle, (*e*) uterus-shaped process of ventral median side of twelfth segment. Treated as above. (Leitz, Obj. 1, Oc. 4).

Fig. 4. Longitudinal section of testis of embryo, about two days before hatching. It will be seen that here testis consists of single cavity with round genital cells and "Hodenzwischenkörperchen" (*h*) scattered in it. Killed with 1°/₀ formic acid and stained with borax carmine. (Zeiss, Obj. J, Oc. 3).

Fig. 5. Longitudinal section of testis of larva just hatched. (*f*) first three depressions on follicular wall; (*i*) second four invaginations. Killed with Flemming's stronger solution and stained with Hermann's triple staining. (Leitz, homog. imm. 1/12, Oc. 3).

Fig. 6. Longitudinal section of testicular follicle, of larva three days old, with invaginated follicular wall and supporting cell (*v*) (Verson's cell). Treated as above. (Leitz, homog. imm. 1/12, Oc. 2).

Fig. 7. Longitudinal section of testicular follicle of larva, one day after fourth moult: left side of figure represents formative zone and right side is place where vas deferens takes its origin. (*v*) Verson's cell; (*h*) "Hodenzwischenkörperchen." Treated as above. (Zeiss, Obj. BB, Oc. 4).

Fig. 8. Blind end of testicular follicle, showing protoplasmic strand (*p*) connecting Verson's cell with follicular wall. Killed with Rabl's platinum chloride and stained with Böhmer's hæmatoxylin. (Zeiss, Obj. D, Oc. 4).

Fig. 9. Verson's cell, with small degenerating cells surrounding it; taken from larva within coccoon. Killed with Flemming's stronger solution and stained with acid fuchsin. (Leitz, Obj. 7, Oc. 4).

Fig. 10. Small portion of testicular follicle of larva in third stage. Lower part of figure represents blind end of follicle. Wall seen at right hand side is follicular wall. (*v*) Verson's cell; (*a*) free area at blind end of follicle in which Verson's cell is normally to be seen. Treated with Flemming's stronger solution and Hermann's anilin-water saffranin. (Leitz, homog. imm. 1/12, Oc. 3).

Fig. 11. Verson's cell (*v*) with surrounding protoplasm and primary germ-cells attached to it. Killed with picro-acetic acid and stained with Delafield's hæmatoxylin. (Leitz, homog. imm. 1/12, Oc. 3).

Fig. 12. Verson's cell (*v*) with surrounding small degenerating cells, taken from testis of imago. Killed with Flemming's stronger solution and stained with rubin. (Leitz, Obj. 7, Oc. 4).

Fig. 13. Verson's cell (*v*) with degenerating cells, taken from testis of imago after copulation. Treated as above. (Leitz, obj. 7, Oc. 4).

Fig. 14. Longitudinal section of terminal portion of ovarian tube, taken from larva in third stage. (*v*) Verson's cell. Treated with Flemming's stronger solution and stained with Flemming's saffranin solution. (Leitz, homog. imm. 1/12, Oc. 3).

Fig. 15. Testicular follicle of Papilio xuthus with Verson's cell (*v*). Treated as above. (Leitz, Obj. 7, Oc. 4).

Fig. 16. Testicular follicle of wild silk worm with Verson's cell (*v*). Treated as above. (Leitz, Obj. 7, Oc. 4).

PLATE IV.

All specimens killed with Flemming's strong solution, except those shown in figs 63, 64, 82, 81 and 86.

Fig. 17. Resting nuclei of primary germ-cells. (*n*) nucleolus, consisting of chromatin granules. Treated with Hermann's triple staining. (Zeiss, homog. imm. 1/12. Oc 4.)

Fig. 18. Two nuclei of same stage with greater portion of cell-bodies. Treated as above. (Zeiss, homog. imm. 1/12, Oc. 5.)

Fig. 19. Two primary germ-cells at beginning of skein stage. Treated as above. (Zeiss, homog. imm. 1/12, Oc. 4).

Fig. 20. Five primary germ-cells, with their Nuclei at stage of segmented skein. In Nucleus represented at right hand side of figure chromosomes are much shortened. Treated as above. (Zeiss, homog. imm. 1/12, Oc. 4).

Fig. 21. Stage of division of primary germ-cells. In left lower nucleus, seen from polar view, twenty-eight chromosomes can be distinctly counted. Treated as above. (Zeiss, homog. imm. 1/12, Oc. 5).

Fig. 22. Primary germ-cells of more advanced stage of division. Twenty-six, or twenty-seven chromosomes are to be counted in polar views. Treated as above. (Zeiss, homog. imm. 1/12, Oc. 4).

Figs. 23-45. Successive stages of metamorphosis of sperm-mother-cells in growing stage. Figures 39, 40, 41, 42, and 43 are stained with Böhmer's hæmatoxylin, and all others with Hermann's triple dyes.

Fig. 23. Resting nuclei. These are very small in consequence of repeated divisions in last stage. (Zeiss, homog. imm. 1/12, Oc. 4).

Fig. 24. Resting nuclei at more advanced. (Zeiss, homog. imm. 1/12, Oc. 4).

Figs. 25 and 26. Nuclei, before skein stage. Chromatin granules are collected irregularly at one side of nucleus. Nucleolus consists of small chromatic bodies. (Zeiss, homog. imm. 1/12, Oc. 4).

Fig. 27. Skein stage. (Zeiss, homog. imm. 1/12, Oc. 4).

Figs. 28, 28′. Granulation of chromosomes. (Zeiss, homog. imm. 1/12, Oc. 4).

Fig. 29. More advanced stage as above. Here chromosomes are completely destroyed. (ditto).

Fig. 30. Chromatin bodies represented in last figure are now collected at centre of nucleus. Single nucleolus is seen in centre of these chromatin bodies. (ditto).

Fig. 31. Nucleus in which chromatin granules again separate from one another and show appearance of normal resting nucleus. Large nucleolus consisting of small chromatin granules is seen. (ditto).

Figs. 32-43. Sperm-mother-cells nearly in same stage of development. (*v*) "Verbindungsbrücken"; (*c*) extruded nucleolus; (*e*) nucleus of cyste. In fig. 40 collection of cytomicrosomes (*b*) is shown. (Same magnification as above.)

Fig. 44. More advanced stage. Chromosomes show ring-like form. (Zeiss, homog. imm. 1/12, Oc. 4).

Fig. 45. Similar stage as above. Each ring broken up into four chromosomes. (Same magnification as above.)

Figs. 46-53. Various stages of first division of sperm-mother-cells. Figs. 46-48 represent early stages of division, showing attraction-spheres, oblique spindle and "Verbindungsbrücken" (*v*); and in fig. 49 polar and central spindles are seen. Stained with Böhmer's hæmatoxylin. (Zeiss, 1/12, Oc. 4). Figs. 50, 50′, 51, 52, spindle stage. Fig. 53 diaster stage of the same. Treated with Hermann's triple staining. (Zeiss, 1/12, Oc. 5 except fig. 50′ which is drawn by Zeiss. 1/12, Oc. 5.)

Figs. 54-60. Second division of sperm-mother-cells, immediately following last division. Figs. 54 and 55, spindle stage. (Zeiss, homog. imm. 1/12, Oc. 5). Fig. 56, diaster stage of same. (Zeiss, homog. imm. 1/12, Oc. 4). Fig. 57 shows polar view of diaster stage. (Zeiss, Obj. 1/12, Oc. 5). Fig. 58, side viw of same. (Magnif. as above). Fig. 59, little more advanced stage. Central and polar spindles have separated from each other. (magnified as above). Fig. 60, more advanced stage of same, showing two cell-plates; (*k*) nucleus. (Zeiss, Obj. 1/12, Oc. 4). Those shown in figs. 54, 55, 56 stained with Hermann's triple staining while rest are treated with Böhmer's hæmatoxylin.

Figs. 61-83. Various stages of metamorphosis of sperm-daughter-cells. Figs. 61, 62, a, b show sperm-daughter-cells with remnant of spindle fibre and collected mirosomes (*m*). (Zeiss, Obj. 1/12, Oc. 4. and 5). Stained with Böhmer's hæmatoxylin. Fig. 62 *c*, *d* represent more advanced stage of the same, showing "Nebenkern" (*n*). Treated and magnified as above. In figs. 63 and 64, cell-body is little elongated to form tail of spermatozoon; (*k*) nucleus (*n*) "Nebenkern" (*m*) mitosome are shown. Acetic acid methyl green preparation and magnified by Zeiss, Obj. J, Oc. 4. Figs. 65-78, 74-76, 78-81 show head and "Nebenkern," of spermatozoa showing successive stages of metamorphosis. (*K*) nucleus, (*n*) "Nebenkern," (*m*) mitosome. Böhmer's hæmatoxylin except fig. 72 which is stained with acid fuchsin and methylen blue. Magnified by Zeiss, homog. imm. 1/12, Oc. 5. except figs. 67, 69, 72, 74, 75 which are drawn with Zeiss, homog. imm. 1/12, Oc. 4. Fig. 81 shows head of nearly mature spermatozoon, killed with picro-acetic acid and stained with picro-carmine. Fig. 82 represents cyste containing nearly matured spermatozoa. At right end of figure large supporting cell is shown. Treated as above. Zeiss, homog. imm. 1/12, Oc. 3. Fig. 83 shows

entire spermatozoon in same stage as fig. 74. (homog. imm. 1/12, Oc. 4.)

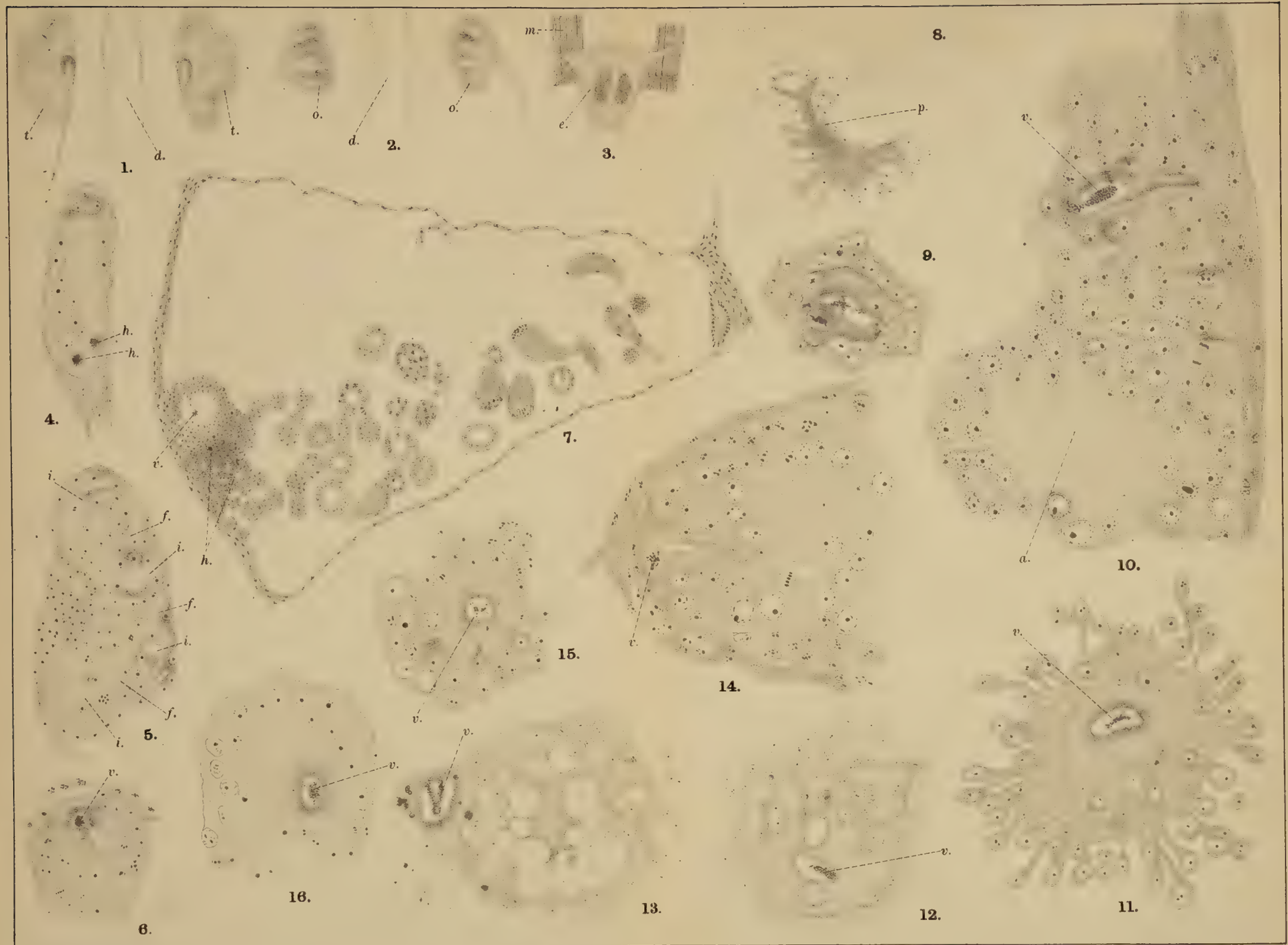
Fig. 69, b. Cross section of tail of spermatozoon at same stage as fig. 69 a, passing through "Nebenkern." Stained with Hermann's triple staining and drawn by Zeiss, homog. imm. 1/12, Oc. 5.

Fig. 73. Similar section of a spermatozoon at the same stage as that shown by fig. 70. Treated and magnified as above.

Fig. 77. Similar section through tail of spermatozoon at same stage as that shown by fig. 83. Treated and magnified as above.

Figs. 84-86. Various stages of "Hodenzwischenkörperchen." Figs. 84 and 85 stained with Hermann's triple staining; fig. 86 with Böhmer's hæmatoxylin. Fig. 84 and 86, Zeiss, homog. imm. 1/12, Oc. 4; fig. 86 Zeiss, homog. imm. 1/12, Oc. 5.

Figs. 87-90. Sperm-mother-cells of Panulirus japonicus, showing resting nucleus with centrosome and archoplasm. Killed with Flemming's stronger solution and stained with anilin-water saffranin. (Zeiss, homog. imm. 1/12 Oc. 3).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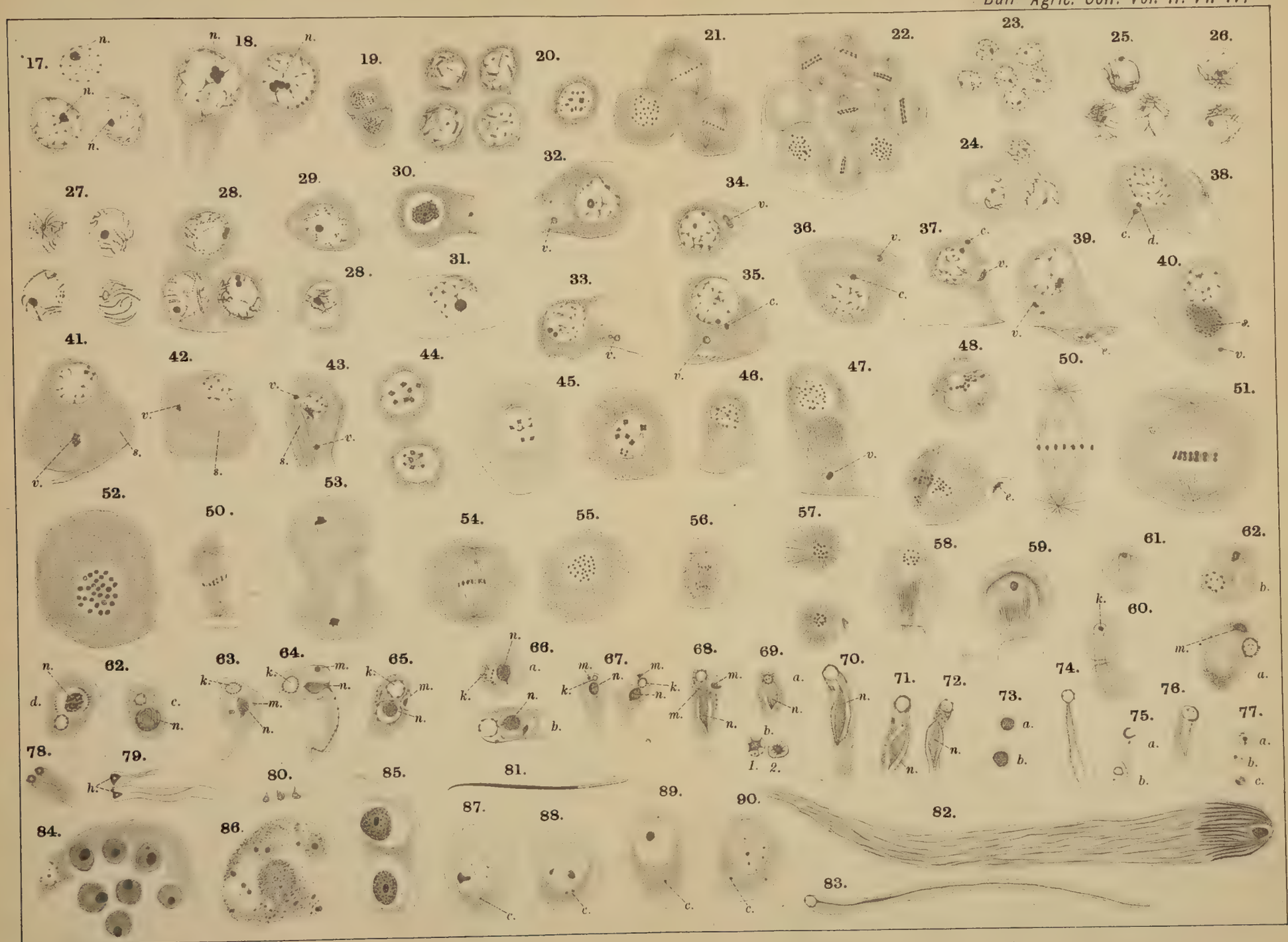
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The Energy of the Living Protoplasm.

BY

Dr. Oscar Loew, *Professor of Agricultural Chemistry.*

Chapter VI.

The Chemical Activity of Living Cells.

The great chemical activity of living cells astonishes the pondering mind. The synthesis of carbohydrates, the transformation of starch into cellulose and fat, the production of the highly complicated proteids are executed with admirable readiness by plant-cells. Animal protoplasm also—although in extent and power of chemical synthesis far excelled by vegetal protoplasm—is capable of many highly interesting chemical operations, such as the construction of living protoplasm out of inert albuminous matter, the formation of hæmoglobin, mucin, elastin, keratin, and glutin from the proteids of the food, the production of enzymes, or the transformation of sugar into fat. And not less remarkable than the synthetical work is the energetic oxidation exhibited by the respiration process.[1]

The character of the chemical work in plant-cells is many-sided: polymerisation, condensation, esterification, formation of amido-compounds, generation of the cyclic constitution, reductions and oxidations are included in it. We find acids and bases, aldehydes and ketones, esters, alcohols, and sulphides in the vegetal kingdom; but neither aldoximes, nor ketoximes,[2] neither sulpho-acids, nor nitro-, nor azo-compounds. Thus, the chemical activity, varied as it is, seems, nevertheless, not to leave certain channels.[3] A number of chemical operations

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(1) See the following chapter.

(2) No derivative of hydroxylamine has as yet been discovered in plant-cells.

(3) It is a notable fact, for which hitherto explanation has not been given, that especially such benzene derivatives as have a *lateral chain of three carbon atoms* frequently occur in plants, some in form of glucosides. I will mention: hesperidic acid, caffeïc acid, melilotic acid, cumarin, umbelliferone, daphnetin, coniferyl alcohol, eugenol, anethol, safrol, cinnamic alcohol and aldehyde, cinnamic acid, thymol, scopoletin, asarone, syringin, æsculetin, absinthol, camphor, the terpenes. Also, tyrosin and phenylamidopropionic acid, as decomposition-products of proteids, have to be mentioned (See Ch. V).

can be carried out by every plant-cell, others only by specifically endowed ones, and, while certain compounds are found in all cells, such as carbohydrates, fats, and proteids, others are not of universal occurrence, though still very frequent, as tartrates, succinates, glucosides, resins, tannin.[1] Others, again, are very rare, being either restricted to one family, as quinine or strychnine, or to a few families, as caffeïn.[2]

In scrutinising the chemical activity of a plant-cell, we have at first to pay attention to the differentiation of the plasmic contents and the division of chemical labour. The cortical layer of the *cytoplasm* has not the same function as the inner layer or *tonoplast;* the former produces the cellulose-wall from starch or sugar, while the latter restrains noxious substances accumulated in the vacuole from returning into the protoplasm. The *leukoplasts* form starch from sugar, thereby preventing a higher concentration of the sugar-solution which would to some extent check plasmic activity. The *chloroplasts* ("chlorophyll-granules"), again, with the aid of ethereal oscillations of a determined wave-length, transform carbonic acid into sugar.[3] The *nucleus*, finally, is charged with the duty of producing the necessary enzymes; diastase is required to bring starch into solution for purposes of transportation and transformation, and proteolytic enzymes to utilise aleurone-grains, during the germination process.

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(1) For the chemical relations and full descriptions of tannins see *Henry Trimble*, The Tannins, Philadelphia, 1894.

(2) Cf. *A. Husemann* and *A. Hilger*, Die Pflanzenstoffe; also *Ed. Schär*, Schweizer Wochenschrift für Pharmacie, **27**, 197. Certain of the accessory compounds may still serve some biological purpose as that of attracting insects for fecundation, or of protection against fungi and animal parasites, while others are useless by-products and mere excretions.

(3) Carbonic acid is often called a *food* for plants, although it is only the material from which plant food (glucose, etc.) is prepared in the chlorophyl-bodies, a logical distinction pointed out by *F. Stohmann* (Z. Biol, **31**, 365). In the assimilation of carbonic acid it is generally assumed that formic aldehyde is the first product. This yields, however, upon condensation in solution, as I have shown, not dextrose but other sugars; moreover, it is poisonous. Therefore, I have added the hypothesis that the formic aldehyde first formed combines with certain hydroxyl-groups in the protoplasm of the chloroplasts, *the amido-groups being protected*. The condensation taking place afterwards must thus lead always to one and the same configuration of the resulting sugar, since the molecules of formic aldehyde have lost their freedom of motion. Cf. *O. Loew*, Ber. D. Chem. Ges. 1889, 484; also, ibid., 473 and 474.

Plant-cells deprived of their nucleus are incapable of transforming starch into cellulose (*Klebs*). They evidently cannot bring on a sufficient saccharification of the starch granules, to provide the cytoplasm with the necessary amount of sugar. For the lowest *animal* forms, an analogous case was proved by *B. Hofer;* amœbæ can no longer digest albuminous particles when deprived of their nucleus. The importance of the nucleus for the secretion processes of animal organisms was also observed by *Verworn*, *Balbiani*, and *Korschelt.* The latter found, for example, considerable changes of form of the nuclei in insects during the secretion of chitin.

The vegetal nucleus seems to be also the manufacturer of the proteids, as first suggested by *Strassburger* and *Schmitz*; at least protein-crystalloids are frequently found in the nuclei of plant-cells, especially in the orders, *Oleaceæ*, *Scrophularineæ*, *Bignoniaceæ*, and in the *Pteridophytes* (*Zimmermann*). For, it does not seem probable that this protein has its source in the cytoplasm and is then transported into the nucleus for crystallisation. Again, in germinating seeds, where protein formation from fragments of decomposed reserve-proteids proceeds with considerable readiness, the nuclei (and also the nucleoli) increase in size.[1] The most important function of the nucleus, however, is connected with the division and multiplication of cells and with sexual propagation in plants and animals.

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(1) *Peters*, Botan. Centralbl. **48**, 181. The nuclei are also often relatively large in the epidermis-cells of leaves, which are especially adapted to store up larger quantities of active albumen (*Bokorny*, *Pflüg.* Arch **55**, 142). Also in the cells of glands relatively large nuclei are often present.

It is also a remarkable observation that plant-cells deprived of their nucleus do not produce any more starch by assimilation. Only certain algæ, containing pyrenoids (Zygnemaceæ) have thus far been observed to be exceptions in regard to starch-production under this condition (*Klebs*). Simpler organisms, like amœbæ and algæ, are especially well suited for experiments with isolated cytoplasm. *Klebs* has, by plasmolysis, *Gerasimoff* by low temperature during the process of karyokinesis, obtained living parts of algæ-cells, or living cells without a nucleus. The life of such cytoplasm, however, did not last longer than about six weeks. On the other hand the nuclei of radiolaria can remain alive, if deprived of the cytoplasm, only 10-15 hours. Nucleus and cytoplasm influence each other by certain of their products (*Verworn Pflüg*, Arch. **51**, 113).

As the main constituent of the nucleus is nuclein[1] and as this is essentially a combination of an albuminous substance with phosphoric acid[2] the importance of the latter becomes at once conspicuous. The important rôle of the nuclein in the division of the nucleus has been demonstrated by staining methods, but it may also be inferred from observations on algæ cultivated in liquids devoid of phosphates. If we place some filaments of *Spirogyra majuscula* in about a liter of distilled water, to which has been added 0.2 p. mille calcium nitrate and 0.02 p. mille ammonium sulphate, and expose the culture to diffused daylight, assimilation as well as protein formation can proceed to a certain extent[3] and even growth of the cells to a considerable size will take place, but *no multiplication* of cells is noticed. Gradually, however, the threads assume a yellowish tinge and commence to suffer. If after about six weeks we divide the filaments, together with the solution, into two portions, adding to one 0.02 p. mille protosulphate of iron, to the other, besides this, 0.08 p. mille disodium *phosphate*, we can observe in a few days, in the latter case, not only the restoration of the brilliant green colour but also the *process of karyokinesis*, in almost every cell, and this too, in the daytime. In the former case, however, where the iron salt alone was added, none of these phenomena was observed, showing, further, that for the production of a normal chlorophyll, phosphoric acid is just as important as iron salts.

The nucleus plays also a certain part in the *organisation* of the cytoplasm. In cases of mutilation, only such cells can be regenerated as still contain the nucleus (*Nussbaum*, *Gruber*). That the *growth* of vegetal cells bears a certain relation to the

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(1) According to *E. Zaccharias*, besides nuclein, plastin also occurs in the nucleus and chloroplasts. Plastin appears to be mainly distinguished from nuclein by its greater resistance to acids and alkalies.

(2) *Liebermann* showed that nuclein contains *metaphosphoric* acid, and *Kossel*, that bases of the xanthin series and nucleic acid are contained in it. My own observations make it highly probable that the nuclein in the living nucleus is present as a lime compound, that is to say, in chlorophyll-bearing plants. With fungi, however, it is different, lime not being at all required by them. Cf. *O Loew*, On the functions of calcium and magnesium salts in plants, Flora, 1892, 368; Landw, Versuch-Stat. **41**, 467.

(3) Traces of *potassium* salts are probably always stored up in the plant-cells.

nucleus was observed by *Klebs* and *Haberlandt*,[1] so that it is probable that the *nucleus* prepares the proteids suitable for the purpose of organisation. The vegetal nucleus performs this by far-reaching synthesis, the animal nucleus by transforming the resorbed peptone.[2]

Clearly, the nucleus of the living cell cannot be identical with that of the dead, and the nuclein known to chemists, extracted with alkalies and precipitated with acids, is a relatively stable compound, which would be entirely incapable of serving the physiological phenomena of karyokinesis, which are made possible only by a highly labile state of the proteid composing the nucleus.[3]

Division of labour, still of restricted compass in a single plant-cell, keeps growing in importance and extent with the development of multicellular organisms, plants as well as animals. Some cells serve mechanical devices, others do

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(1) Biol. Centralbl. 8, 133.

(2) I consider the process of organisation as a sort of polymerisation, in which only molecules of *equal configuration* can participate, and in which isomeric and stereo-isomeric molecules would be hurtful, the mutual reaction of their labile groups being facilitated (Cf. *O. Loew*, Natural System of Poisonous Actions, Ch. V. On the *poisonous proteids*, 82). This, again, would imply a specific tectonic for the nuclei of different species as the necessary condition for yielding one and the same active albumen for the organisation of each cytoplasm. This view could also furnish a plausible explanation of certain observations in regard to the propagation of the species. A specific configuration of the nuclein will naturally lead to a specific tectonic of the nucleus, *i.e.*, the invisible *anatomical* structure will be in close connection with the configuration of the proteid. Such considerations may finally also throw some light upon the fact, that the fibrins, the oxyhæmoglobins, the alexines of different species are by no means identical. The possible stereo-isomers of a proteid reach evidently to an immense number, even if we start from one and the same active peptone. [Stereo-isomerism conceives of compounds as containing the same elements in the same proportion and arranged in the same groups, and yet differing in properties, because of a different arrangement in *space* of the constituent groups].

(3) Various observations prove that the nucleus is even of much greater lability than the cytoplasm. The problem of karyokinesis appears still more complicated now that the centrosomes have been observed, initiating the division.

Differences have been observed between the nuclei of nerves, glands, and muscles; further, between those of the male and female sexual cells, the former being richer in nuclein (*E. Zaccharias*). Still greater must be the differences between the nuclei of the germ-cells and those of the somatic cells, especially in animals.

specific chemical work, and others again are adapted to functions of propagation, while in the animal kingdom special organs for visible motion and for sensation are developed. The "chemical factories in the service of an organism," the *glands*, of simple structure in plants, but forming complicated organs in the higher animals, betray again a far-reaching differentiation. They may secrete enzymes, carbohydrates, different acids, fat, or wax. Products secreted by *vegetal* cells alone are terpenes and resins.[1] Glands secreting poisonous compounds (tox-albumins; carbylamines (?)) occur in the mouth of snakes, in the skin of the toad, on the feet of scolopendras. Crustaceans and beetles produce chitin, spiders and caterpillars fibroin. Carabidæ secrete butyric, bees and ants formic acid. Especial interest is connected with the anal glands of the skunk,[2] musk deer, beaver, and civet. Again, the livers of different animals vary in their actions, as must be inferred from the composition of bile and urine. Dogs can produce ethyl sulphide (*Abel*) and an oxyquinoline-carboxylic acid (*Kretschy*), birds ornithuric acid;[3] the bile of geese contains chenotaurocholic, that of swine hyotaurocholic acid. Birds and snakes produce more uric acid than urea, while the reverse is the case in mammalia. The products of metabolism exhibit, thus, considerable discrepancies.[4]

This very brief survey may bear sufficient testimony to the variety of the chemical work of organisms, and to the special adaptation of the plasmic energy to the most varied chemical performances. Few authors have thus far tried to propound an

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(1) An elaborate treatise on the resin-producing glands of the conifers was recently published by *H. Mayr*, formerly professor in the Imperial University of Japan.

(2) The yellow liquid secreted by the skunk-glands and ejected in self-defence is a primitive and effective weapon, having a most repulsive odour. It contains 16 per cent of sulphur (*Swarts*), and is probably a mixture of several mercaptans with one or more nitrogenous compounds.

(3) This acid, a dibenzoyl-ornithin, is secreted after introduction of benzoic acid; ornithin again is probably a diamido-valerianic acid (*Jaffé*).

(4) Also, pathological processes may be caused by administration of certain compounds only in certain animals; thus phloridzin will produce diabetes in dogs, but not in rabbits or frogs.

acceptable hypothesis for this activity. *Nägeli* in his attempt to explain the fermentative activity of the yeast-cell assumes a *certain kind of motion* in the living protoplasm, imparted to the glucose molecules, loosening affinities, and leading to disruption into carbon dioxide and alcohol. *Mc. Laughlin* went still farther, applying the laws of oscillations established by physicists to the action of bacteria in infectious diseases.(1) But neither *Nägeli* nor *Mc. Laughlin* touched the question why such energetic motions stop at once on the death of a cell, although the conclusion that the *living* protoplasm must consist of easily changeable, labile proteids was close enough at hand. *Mc. Laughlin* expresses his views upon the fermentative action of bacteria and yeast-cells in the following words: "The distinctive energy or waves of a cell can influence those substances only, whose waves bear a certain relationship to those of a yeast-cell; and they must be equal in their periods, direction, and, perhaps, in other characteristics, before those on one side can influence those on the other. The nature of this influence will again depend on whether the two sets of waves coïncide in trough and crest. If they do, the waves will supplement each other and their amplitude will be enlarged; if they do not, they will antagonise each other, and their amplitude will be diminished, or, it may be, the waves will be destroyed by mutual antagonism; it will be remembered that all this occurs in waves of sound, of light, and of water, and, if analogy has any merit, it can occur in waves of molecular energy." Such considerations appear to be justified, but there exist doubtless other influences which may modify the expected result, such as the configuration of the plasmic proteids and the tectonic of the plasmic apparatus (see pag. 163, foot note). Further, it must be borne in mind that the wave motions starting from the *living* protoplasm are of a far more energetic nature than the molecular oscillations of any other material in the cell.

The chemical performances of living organisms could not fail

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(1) Fermentation, Infection, and Immunity, *Austin*, 1892. This treatise starts, however, on several occasions from assertions which recently have been proved to be incorrect. The toxalbumins of the infectious diseases are not produced from *animal* proteids by fermentative actions, but are *secretions* of the *bacterial* protoplasm which are formed even in culture media devoid of proteids.

to arouse the envy of the chemist and instigate him to try to accomplish the same ends. To these endeavours we owe a long series of interesting syntheses since the artificial preparation of urea by *Wöhler* in the year 1828. Carbon and hydrogen were united in the electric arc by *Berthelot;* acetylene, thus formed, leads, among other things, to ethylene, ethyl alcohol, acetic acid, aldehyde, acetone, and glyoxal. Acetylene yields at low red heat benzene, from which, again, numerous derivatives can be obtained. Acetone, further, may easily be converted into trimethyl-benzene, aldehyde into trimethyl-pyridine; from pyridine, again, conine may be reached (*Ladenburg*). Glyoxal leads, by way of its cyanhydrin, to tartaric acid.

Carbon can be united with aluminium and this product yields, by decomposition with water, methane (*Moissan*). Methane, again, yields methyl alcohol and formaldehyde, while the latter yields by condensation several kinds of sugars (*O. Loew*). Formic acid can be obtained by the action of sodium upon moist carbon dioxide (*H. Kolbe*), or by the action of iron filings upon bisulphide of carbon in presence of water in sealed tubes at 100° (*O. Loew*). Oxalic acid results by passing dry carbon dioxide over hot sodium amalgam (*E. Drechsel*), or by treating the product of reduction of bisulphide of carbon by sodium amalgam with fusing potash or boiling baryta water (*O. Loew*). From a mixture of oxalic ester and acetic ester aconitic acid can be obtained (*L. Claisen* and *E. Hori*); from acetone and oxalic ester, oxytoluic acid, and from this an anthracene derivative, (dimethyl-anthrarufin) was obtained (*Claisen*). From malonic ester phloroglucin can be reached (*A. Baeyer*), from succinic ester hydroquinone, from malic acid oxynicotinic acid and daphnetin (*Pechmann*).

These and similar synthetic processes, are, however, for the most part only possible by the application of powerful agents, such as strong bases or acids, sodium alcoholate, sodium amalgam, chloride of zinc, etc., and partly by the aid of high temperature; while *no light is thrown upon the special method followed by the living protoplasm* of plant-cells, a material consisting of proteids of neutral reaction or nearly so, and very easily changed by any substance with powerful affinities. The chemical agency consists here merely of specific waves. We are acquaint-

ed with chemical actions caused by waves of heat, light,[1] electricity, and even by the waves of sound in some instances (explosion of iodide of nitrogen), but concerning the related phenomenon of chemical action set up by oscillating motion of the labile (unstable) position of atoms, our knowledge is but very scanty. Such processes are of the kind termed katalytic actions.[2] This expression was first used by *Berzelius* to designate chemical phenomena apparently caused by mere contact with a certain substance. The unsatisfactory definition of *Berzelius*, and the denomination of certain processes as katalytic which in reality were not such at all, implied a misunderstanding, and when *Liebig* ridiculed the idea of *Berzelius*, nobody seemed to dare any more to speak of this interesting group of phenomena and to explain satisfactorily, for example, the wonderful activity of platinum black.[3]

Katalytic actions exist, however, but they are not the result of a mere contact, as *Berzelius* believed, but of a certain amount of energy being conveyed, whereby the katalyser remains entirely intact. If, however, the apparently katalytically acting substance undergoes intermediary chemical changes with final regeneration, the process is not a katalytic one. Such *pseudo-katalytic* actions are, for example, the rôle of nitric oxide in the manufacture of sulphuric acid, that of cobaltic oxide in the development of oxygen from chloride of lime, the action of

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(1) The action of *light* may consist in bringing about (*a*) combinations, as that between chlorine and hydrogen, or (*b*) disruptions; bisulphide of carbon is split into sulphur and a lower sulphide (*O. Loew*); aqueous sulphurous acid is split into sulphur and sulphuric acid (*O. Loew*); nitric acid into oxygen and nitrous acid; silver salts are reduced to metal; (*c*) reductions of organic compounds: in *alcoholic* solution quinone is changed into hydroquinone, nitrobenzene into aniline (*Ciamician* and *Silber*), benzil into benzil-benzoin, phenanthrene-quinone into phenanthrene-hydroquinone, a portion of the alcohol present being converted into aldehyde; (*d*) polymerisation and condensation; thymoquinone, anethol, phenyl-naphtoquinone are polymerised; monobromacetylene is converted into tribrombenzene, propargylic acid into trimesic acid (Ber. D. Chem. Ges. **27**, 958).

(2) The great resemblance of the chemical activity of living cells to katalytic actions was recognised more than thirty years ago by the great physiologist, *C. Ludwig*. Also *C. Lehmann* in his "Lehrb. d. physiolog, Chem.," and, later on, *Traube* and *Stohmann* expressed themselves in the same sense. But explanation of this katalytic action was wanting.

(3) Even now-a-days, isolated voices are raised in the sense of *Liebig*. See *H. Macleod's* lecture at the meeting of the *British Assoc.* in *Edinburgh* 1892.

aluminium chloride in the synthesis of hydrocarbons, that of zinc chloride in the transformation of glycol into aldehyde, and the accelerating action of iron and copper salts upon the oxidation of phenol by peroxide of hydrogen.[1]

The genuine katalytic actions may be divided into three groups:

1. Katalysis by labile organic compounds,
2. Katalysis by mineral acids, caustic lyes, and certain salts,
3. Katalysis by finely divided metals.

In regard to the first group may be mentioned the conversion of dicyanogen into oxamide by a dilute solution of ethylic aldehyde, a reaction observed by *Liebig;* the transformation of thiourea into the isomeric ammonium thiocyanate by an alcoholic solution of ethyl nitrite (*Claus*); the facilitating action of acetic ester upon the combination of hydrocyanic with hydrochloric acid (*Claisen* and *Mathews*). Maleïc acid transforms ketazines into the isomeric pyrazolines with liberation of heat,[2] whilst fumaric acid can only accomplish this at a temperature of 100.° To this group of actions belongs evidently not only the action of the living cells, but also the action of the enzymes, which have a high degree of lability and betray, by their easily passing into an inactive state, as well as by their proteic nature, a certain relation to the proteids of the living protoplasm. The fact that dilute formic aldehyde destroys their activity even in perfectly neutral solution at the ordinary temperature, makes the presence of highly labile amido-groups probable.[3]

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(1) Chem. Centralbl. 1885, p. 224. In certain cases the *apparently* katalytically acting substance is mainly a suitable medium to bring two compounds into more intimate contact with each other, or by combining with one of two compounds present to help to loosen somewhat certain affinities in the molecule, and thereby bring about combination with the second compound.

(2) *Curtius* and *Foersterling*, Ber. D. Chem. Ges. **27**, 770. *F. Stohmann* determined the thermic value of maleïc acid to be 326.3 cal. and that of fumaric to be 319.7; the latter possesses, therefore, less energy than the former. *Stohmann* recognised by direct experiment, in determining with great exactness the heat of combustion, that labile compounds always have a higher thermic value than the isomeric stable ones.

(3) *O. Loew*, Jahresber. f. Thierchem. 1888. I have observed also that a solution of prussic acid of 25 % destroys in twelve hours the diastatic but not the proteolytic enzyme of the pancreas (*Pflüg.* Arch. **27**, 208). Cf. also *Schär* and *Fichter*, Jahresber f. Thierchem. **5**, 269. Certain bacterial enzymes are rendered inactive by sulphuretted hydrogen (*Fermi* and *Bernossi*. 1894). Chloroform retards enzyme-action (*Salkowski*). According to *Arsonvale* (1894) enzymes are rendered inactive by a temperature of—150°C.

In the second group of katalytic actions may be counted the transformation of maleïc into the isomeric fumaric acid by mineral acids, of maleïc ester into fumaric ester by contact with hydrochloric acid at the ordinary temperature (*Skraup*) and of citraconic into mesaconic acid (*Delisle, Franz*); of hydromellitic into isohydromellitic acid by hydrochloric acid (*Baeyer*); of dihydroterephthalic into an isomeric acid by a solution of caustic soda, the formation of paramidophenol from phenyl-hydroxylamine (*E. Bamberger*) and that of paranitroso-compounds from nitrosamines by acids. Also the transformation of oleïc into elaïdic acid by nitrous acid deserves mentioning.

In connection with the third group we mention the following observations: platinum black brings about an oxidation of hydrogen, of alcohols, and of various other compounds; it unites sulphur dioxide with dry oxygen to form sulphur trioxide; it combines hydrogen with hydrocyanic acid into methylamine at 110° (*Debus*); it transforms a mixture of nitric oxide and hydrogen into ammonia and water; it accelerates the decomposition of hydroxylamine in presence of caustic potash; it decomposes peroxide of hydrogen energetically; it transforms ozone into common oxygen (*Mulder*); it decomposes azoimide into ammonia and nitrous oxide (*O. Loew*), and nitrososulphates into sulphates and nitrous oxide (*Pelouze*).

Finely divided iridium or rhodium decomposes formic acid into carbon dioxide and hydrogen (*Deville* and *Debray*); palladium powder effects an oxidation of hypophosphorous acid with liberation of hydrogen;[1] finely divided copper incites a rapid decomposition of formic aldehyde by caustic potash with liberation of hydrogen,[2] it also decomposes diazobenzene chloride into nitrogen and chlorbenzene at low temperatures.[3] Zinc filings condense at 100° acetaldehyde to aldol and crotonaldehyde.

All these actions of finely divided metals can be best explained by the assumption that a *modification of heat waves* takes place in such a manner that this energy can now pass more easily *into chemical energy*. With platinum black this

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(1) *Engel*, Compt. rend. **110**, 786. The chemical explanation given by this author is certainly incorrect.

(2) *O. Loew*, Ber. D. Chem. Ges. **20**, 145.

(3) *Gattermann*, ibid. **23**, 1218 and **25**, 1091, footnote.

modification is carried still farther by the dense layer of *oxygen* surrounding the metallic particles.[1]

The katalytic action of mineral acids is evidently also due to a certain motion in the molecules.[2] A motion of different character, however, must be assumed in organic compounds of a certain lability (cf. Chap. III). Usually the katalytic reactions are exothermic ones, but in special cases, where other agencies render their aid, also endothermic, as in the action of the chlorophyll-bodies upon carbonic acid in sunlight.

The katalytic powers of platinum-black are evidently of a very inferior character, compared with the faculties of living protoplasm,—we notice above all an entire want of condensing influence—but in regard to simpler reactions a parallelism can nevertheless be shown to exist, of which I here adduce some further proof. One of the most general synthetical processes is the formation of fat from glucose in living cells, a process consisting in condensation and reduction :

$$3\ C_6\ H_{12}\ O_6 - 16\ O = C_{18}\ H_{36}\ O_2$$

(stearic acid)

$$C_6\ H_{12}\ O_6 + 4H = 2\ C_3\ H_8\ O_3$$

(glycerol)

The remarkable transformation of sugar into the higher fatty acids has thus far not yet been imitated, but we can at least obtain lower fatty acids of rancid odour if we mix a 10 % *glucose* solution with about half its weight of active platinum-black ; the odour will be perceptible after 1-3 hours and increase gradually. The main action, of course, is a direct oxidation, but simultaneously a reduction is going on in other molecules which yield up a part of their oxygen also to glucose molecules under the influence of platinum-black.[3] Neither lævulose nor cane sugar will yield this result. Platinum-black, also, deprived of its absorbed oxygen in one way or other, is inactive in this regard.

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(1) Platinum-black can absorb 800 times its own volume of oxygen (*Doebereiner*), but this *alone* would not suffice to explain its oxidising power, compressed oxygen possessing no increased energy at ordinary temperatures. Cf. also *O. Loew*, Ber. D. Chem. Ges. **23**, 290 and 677, where I gave first the above explanation of the katalytic action of platinum black.

(2) We will not enter here upon the most recent views in regard to the action of acids, more light being still necessary.

(3) *O. Loew*, Ber. Deutsch. Chem. Ges. **23**, 865.

If we add, for example, to the mixture mentioned, sodium carbonate, or boil the mixture with addition of calcium carbonate, no trace of the rancid smell will be noticed after addition of a mineral acid; the absorbed oxygen is here too quickly used up for oxidation.

Another process, hitherto unexplained, is the easy reduction of nitrates to ammonia in the formation of proteids (cf. Chap. V). As there exists no nascent hydrogen in the living cells, I had long entertained the view that glucose under the katalytic influence of the living protoplasm would be the reducing agent, and recently have succeeded in imitating this reduction by means of platinum-black. I heated in my first experiment a solution of 3 g. potassium nitrate and 10 g. glucose, in 300 g. water with 110 g. platinum-black for 6 hours to 60-70° and found that 45.6 % of the nitrogen of the nitrate had been converted into ammonia. This reduction can even succeed at the ordinary temperature. If 50 cc. of a mixture of a 5-10 % glucose solution with 1-2 % calcium nitrate and 10 g. platinum-black is left to stand for 4-5 days in a closed flask, we observe upon supersaturation with caustic lye a strong ammoniacal odour, while in a control experiment without the platinum no trace is observable.[2] If we modify the experiment by increasing the amount of the nitrate to three times that of the sugar, we find on heating that the acid reaction generated at first soon diminishes and finally gives way to an alkaline one, and then the ammonia previously formed becomes very perceptible by its odour.[1] The platinum-black imparts to the hydrogen atoms of the glucose increased motions, thereby loosening the existing affinities, and awakening others, whereby a reduction of the nitrate is caused, *i.e.*, an exchange of oxygen and hydrogen between the nitrate and the sugar.

In a similar way, chlorates are reduced to chlorides; sulphates however resist its action and require evidently more

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(1) Other control experiments were also made, which proved beyond any doubt that only the platinum-black itself and not any oxidation product or bacterial action was the cause of the formation of ammonia.

(2) If the mixture is rendered alkaline *before* the platinum-black is added, no ammonia will be produced, a result which finds its explanation in what has been mentioned above.

energy; but at least with a certain sulpho-acid, the combination of formic aldehyde with acid sodium sulphite, I succeeded in effecting reduction; for this in presence of sodium carbonate yielded by moderately heating with platinum-black, small quantities of sodium sulphide,[1] while the odour of methyl mercaptan became perceptible.

The katalytic action of platinum-black is manifested still in another case of physiological interest. If moistened with pure caustic lye and exposed to pure air it forms from nitrogen and water nitrous acid and ammonia to a small extent.[2] Such a process may take place when nitrogen is assimilated by leguminous plants whose roots have entered into symbiosis with certain bacteria. The reverse process can also be katalytically accomplished;[3] for a neutral solution of ammonium nitrite, which is only decomposed by application of *heat*, will in presence of platinum-black show a continuous development of nitrogen at the *ordinary temperature*. A mixture of 6 g. ammonium sulphate with its equivalent quantity of potassium nitrite dissolved in 130 cc. water developed after addition of 20 g. platinum-black in 24 hours 191 cc. nitrogen, and in 5 days as much as 768 cc., at 15° and 723 mm. barometric pressure. A similar process takes place in cases of putrefaction when nitrates are present, where the protoplasm of the bacteria present acts upon the nitrite of ammonia formed and liberates nitrogen.

In all the cases described here the platinum-black remains exactly what it was; it does not act by virtue of any chemical affinities, but only by a specific mode of motion. Analogous to this is the action of living protoplasm; it remains what it is while it produces various chemical changes in compounds that come into contact with it. If it acted *by means of* chemical affinities, it would undergo a change, and that would mean the death of a cell when that change amounted to more than slight traces in the unit of time. There can be no doubt that the *active principle is an intense and ceaseless motion of atoms* intimately

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(1) We might express this result by the following equation:

$$2\,CH_2OH.SO_3Na + 4Na_2CO_3 = Na_2S + SO_3Na_2 + HCOONa + 5NaHCO_3$$

Compare *O. Loew*, Ber. Deutsch. Chem. Ges. **23**, 3125.

(2) *O. Loew*, ibid. **23**, 1443.

(3) *O. Loew*, ibid. 3019.

connected with the chemical constitution of the *proteids composing the living protoplasm* (cf. Chap. III and V), and intensified by the respiration process (cf. the following chapter).

Grant Allen in his admirable treatise "Force and Energy" gives the following "Table of kinetic energies:"

Separative.	Separative molar motion. (In a body raised from the earth's surface).	Separative molecular motion. (In a body torn apart).	Separative atomic motion. (In chemical decomposition).	Separative electrical motion. (In an electrical machine).
Aggregative.	Aggregative molar motion. (In a falling body).	Aggregative molecular motion. (In a body cooling).	Aggregative atomic motion. (In chemical combination).	Aggregative electrical motion. (In lightning).
Continuous.	Continuous molar motion. (In a top or in a planet).	Continuous molecular motion. (Motion in heat).	*Continuous atomic motion Unknown.*(1)	Continuous electrical motion. (In magnet).

Now, the energy produced by continuous atomic motion, for which *Allen* could not cite an example, must be identical with that displayed by atoms in labile position. The foremost example of such energy is represented by *Plasmic Energy*.

Chapter VII.

Respiration.

Philosophers who have recognised respiration as the principal foundation for all the other vital functions have frequently compared the living organism with a machine using coal; in both cases a liberation of energy by combustion and the application of more or less of it for various useful performances are taking place. This comparison, however, is only admissible

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(1) The italics are mine.

within a very narrow compass, since the difference becomes great with an increased supply of oxygen. Hereby, the coal will burn with much greater vigour, whilst respiration will not be intensified, because the amount of oxygen needed is regulated by the living cell (*Pflüger*).

The respiratory intensity not only exhibits great differences in the various species of organisms,[1] but also in different organs of one and the same organism.

The intensity is greater in flowers than in leaves and roots,[2] greater in leaves than in stem and fruits (*Saussure*), greater in light-plants than in shade-plants (*Adolf Mayer*), greater in shoots of oil-seeds than in those of starch-seeds (*Godlewski*), greater in air-plants than in hydrophytes (*Boehm*), in the cat double what it is in the sheep (*Munck*).

While increase of *pressure* of oxygen will not influence the intensity of respiration, the effect of *rising temperature* is, on the other hand, very considerable, the activity of the protoplasm being thereby greatly enhanced. At 0° the respiration of plants is very slight, at 17-20° it is already twenty times more intense, and still gradually increases with the temperature nearly up to that of death. Cold-blooded animals respire less than warm-blooded,[3] while animals in hybernation exhibit a lower temperature and respire less than those in activity.

Heat, visible motion, chemical action, and, in certain cases,

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(1) To-day it seems hardly credible that *Liebig* still maintained that chlorophyll-bearing plants will not carry on respiration, although *Saussure* had positively proved to the contrary as early as 1805! Another erroneous conception, viz., that the *blood* is the principal seat of respiratory oxidation in animals was corrected in the year 1868 by *Pflüger*, who has recently told us what enormous labour for years it took him to convince physiologists of the truth that oxidations in animals are accomplished by the *cells* of the various organs.

(2) The root-ends of young plants of *Vicia Faba* consume in 24 hours 5 per cent of their dry matter (*Palladin*). Young rootlets and especially root-hairs have an energetic respiration, while the interior of large roots respires certainly much less than leaves. Not only the restricted access of air but also the lower temperature to which usually roots are exposed in greater depth will under ordinary conditions lower the intensity of respiration.

(3) The intensity in frogs and earthworms is only about one tenth that in the dog; that of higher plants is generally found less than that of warm-blooded animals, in many cases also less than that of cold-blooded, if equal weights of *dry* matter are considered. It is with pea-shoots about one half that of the frog, while in well nourrished mould fungi it considerably surpasses even that of mammalia.

electrical phenomena and light are the forms of energy resulting. A stratum of germinating barley, 15 cm. high, at an air temperature of 7°, reaches, after a few days, a temperature of 18°. One grm. of a stalk of *Brassica* liberates by respiration in one hour an amount of energy equal to 132.1 gram-meter, amounting for one cell per minute to 2.2 milligram-millimeter (*Rodewald*). The greater part of the liberated energy assumes the form of heat and is dissipated. Bees produce so much heat that their hives show even in winter a temperature of 30°. Rabbits, with a blood temperature of 38°, consume per kilo. and per hour 0.914 grm. oxygen, while chickens, with one of 43.9°, consume 1.186 grm. of it. Man produces every hour as much heat as would raise the temperature of an equal amount of water 1.4 degrees.

Every increase of muscular exertion requires an increase in respiration; the work done by a muscle corresponds to about 33 per cent of the energy yielded by respiration, while in a steam-engine only 10 per cent of the caloric value is secured in the form of work.[1] An animal, therefore, considered as a machine, works economically (*Zuntz*).

Even the finest *currents* in the protoplasm depend upon the presence of oxygen, as *Kühne* has shown, and the increased *work* connected with a rapid development of shoots and embryos, or with the transportation of starch in plants requires also an increase of respiration. Further, the dependence of the production of *light* by fungi and by various animals upon respiration has been proved, and there can be no doubt also that it is the same with regard to the production of *electricity* in the nervous system and in the electrical organs of fishes.

The function of respiration consists, not in all cases, however, in merely yielding kinetic energy; it serves also to prepare useful

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(1) The knowledge of the caloric values of the different compounds encountered in organisms being of high physiological interest, *Stohmann* has determined them with great exactness recently. We mention a few data. The caloric values of 1 gram amounts to, in:

Egg-albumen	5,735.2 cal.
Peptone	5,298.8 „
Leucin	6,533.0 „
Fat	9,509.0 „
Glucose	3,742.6 „

oxidation products, as carbohydrates from fats in plants,[1] and it helps to prepare from different materials the necessary starting groups for protein formation (cf. Chap. V).

While a unicellular organism obtains the necessary oxygen by a simple diffusion process, more or less complicated contrivances are necessary to provide the interior cells of multicellular organisms with air. Stomata, lenticells, and intercellular spaces serve this purpose in the vegetable kingdom; tracheids, gills, lungs, hæmoglobin, in the animal kingdom. Movements of the abdomen and thorax in insects, of the gills in aquatic animals, of the chest in lung-bearing animals, maintain the exchange of oxygen against the resulting carbon dioxide. Certain insects, as the larvæ of the *Libellulidæ*, and even a fish (*Cobitis fossilis*), exhibit the remarkable exception, of carrying on their respiration by the *intestines*, which are provided for this purpose with innumerable blood vessels.

Not all organisms, however, produce their physiological energy by respiration; the fermentative organisms gain it without the aid of oxygen, by decomposition of organic matter,[2] Bacteria can utilise various hydroxy-acids, proteids, polyvalent alcohols and sugars, while the yeasts certain kinds of sugar only. We have here the case of the so-called *intramolecular respiration* before us, one which yields considerably less energy than normal respiration. Also certain animals can for a limited

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(1) The formation of organic acids is also due to respiration, viz., to an imperfect oxidation of sugar in most cases. An interesting example is furnished by the flowers of *Ipomæa triloba*, which are *blue* in the morning and remain so during cold foggy, and rainy days, but turn *red* on warm bright days. Since this change from blue to red can also be easily accomplished by acids, we must assume that the increased respiration on warm days causes the production of acids.

(2) The fact that bacteria can be deprived of their fermentative faculties, without their life being impaired and thus be turned from anaërobs into obligate aërobs, has led me to the view, that there exists a special organoid in those organisms endowed with fermentative action. This would, to a certain degree, be analogous to the chloroplasts of green plants; the latter prepares suitable material for growth from carbonic acid, while the former prepares it by decomposing various organic matters. A small fraction of these fermenting compounds does not appear in form of fermentation products, but in that of new cells of the fermenting organism. We see therefore, here also a double part played, viz, that of liberating energy and that of preparing the necessary groups for protein formation. Cf. *O. Loew*, Centralbl f. Bacteriologie **9**, Nr. 22.

time subsist on intramolecular respiration, as *Pflüger* has observed in frogs, and *Bunge* in worms.[1]

Although the comparison of respiration with direct combustion was close at hand, still there were many mysteries involved and many questions unsolved, in regard to the laws and to the causation of that energetic combustion going on at relatively low temperatures in a substance containing 75 per cent water and more, and yet remaining apparently intact, while effecting the union of the resorbed food with free oxygen. That the protoplasm remains alive while this fierce and destructive oxidation is carried on, appears the more notable as it is known how easily all kinds of living cells are killed by oxidising media in high dilutions, as by peroxide of hydrogen or by potassium permanganate.

The views propounded by various authors exhibit considerable discrepancy. The oldest hypothesis, that of *Schönbein*, assuming the formation of *ozone*, had soon to be discarded. But nevertheless, the idea that the common oxygen had to be changed into an *active form* or modification *before* it could unite with the compounds in the cell, prevails also in the other theories. The supposed activifying process consisted in the splitting of the oxygen molecule into its two atoms with free affinities.[2] *Hoppe-Seyler* supposed that the living cells produce hydrogen, which in its nascent state could accomplish the "activifying" process by combining with one of the atoms and setting the other free. But it was objected that hydrogen ought to make its appearance at the moment oxygen is being withdrawn. This was, however, never observed. Germinating seeds can exist one day, certain worms (*Ascaris*) even 5-7 days, alive in absence of oxygen, but no trace of hydrogen is evolved by these organisms during that time.[3] *Reinke* holds that there exist in the living cells easily oxidisable organic matters, "autoxidisers," which are capable of suffering

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(1) With insufficiency of oxygen, animals will show albumen, glucose, and lactic acip in the urine (*Araki*), also an increase of oxalic acid (*Reale* and *Boeri*).

(2) This process would require a large amount of energy. Heat alone can accomplish it only at a temperature not lower than 1400° C. (*Troost* and *Hautefeuille*).

(3) *M. Traube* contends, moreover, that nascent hydrogen can activify oxygen; it can merely produce peroxide of hydrogen.

oxidation in contact with molecular oxygen, so as to produce peroxide of hydrogen, which under the influence of enzymes would bring about powerful oxidations.[1] But *Reinke* omitted to prove that the supposed "autoxidisers" would be really capable of inducing oxidations of sugar or fat, while as regards that peroxide its absence in plant-cells has been proved by *Th. Bokorny*[2] and by *W. Pfeffer*.[3] Neither could it be discovered in animal cells. *Reinke's* view moreover could not explain how respiration, throughout such a wide range, is independent of the amount of oxygen present. But the belief that there exist in many plants easily oxidisable compounds is no doubt true. Many plant juices acquire soon a reddish or brown coloration, *if exposed to air*, a phenomenon which illustrates how different a course is that taken by respiration proper, since these same compounds were no doubt *formed* in the protoplasm and afterwards gradually secreted into the vacuole. Numerous plants, however, do not yield a juice of like behaviour, nor has this been observed in animal juices. *Reinke's* observations have therefore no connection with the respiration process.

The theory of *Traube*[4] assumes the existence of *oxidising enzymes*, which would act as transporters of oxygen, somewhat like nitric oxide in the manufacture of sulphuric acid.[5] The occurrence of such enzymes was not proved by *Traube*, but has been demonstrated a year ago beyond any doubt by *Toyonaga*, who, at my request, made a series of investigations. These enzymes are the cause of the darkening of the juices of many plants when easily oxidisable matters are present, as in potatoes, in the roots

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(1) Botan. Zeitg. 1883. Nr. 5 and 6.

(2) Ber. Deutsch. Chem. Ges. **21**, 1100 and 1848. *Pringsh.* Jahrb. **17**, 347.

(3) Ber. Sächs. Akad. d. Wiss, 1889. Recently the presence of H_2O_2 in various plants has again been asserted by *Bach*, but his reaction was unreliable (cf. *Cho*, this bulletin, and his conclusion not justified).

(4) Theorie der Fermentwirkungen, Berlin, 1858. *Virch.* Arch. **21**, 386. Ber. D. Chem. Ges. **10**, 984.

(5) Analogous processes are the action of ferrous salts in the oxidation of tartaric acid in sunlight (*Vries*), the oxidation of aniline by a slight trace of ammonium vanadate (Bull. soc. chim. **45**, 309) or the oxidation of nitrogenous compounds when added to a solution of oxide of copper in ammonia exposed to air (*O. Loew*, Z. Biol. (1878); Journ. f. prakt. Chem. 1878). Another example, sometimes cited, viz., the oxidation of indigo-white and its regeneration by alkaline glucose solution is for obvious reasons not well suited for comparison in this connection.

of *Daucus*, *Beta*, *Lactuca*, and *Taraxacum*. Among the algæ *Zygnema* may be mentioned, whose fresh juice turns black, and among the fungi *Boletus luridus*, whose freshly cut surface turns blue in contact with air.[1] If, however, oxidising enzymes are present while those oxidisable compounds are wanting, then the existence of the former can be shown by adding guaiacum solution or hydroquinone, pyrocatechin, or pyrogallol. Guaiacum will yield a blue color, the latter a brown or black one. *Schönbein* observed this blue reaction in various seeds, and especially well in those of *Cunara*;[2] *Molisch* in the secretions of various roots, as those of *Pisum*, *Brassica*, *Cucurbita*, *Lepidium*, *Scorzonera* and *Neottia*.[3] Some observations of *Pfeffer* have made it probable that the supposed enzymes are contained in the *protoplasm* itself, and come therefore into intimate contact with the easily oxidisable compounds contained in the *cell-sap* only after the death of the cells, when the osmotic properties of the tonoplast have gone.[4] That the blue colouration of guaiacum is also due to the action of an enzyme is supported by the fact that fresh diastase can produce the same reaction.[5] I have further observed that an enzyme-like compound of proteid nature can be precipitated from potato juice by alcohol, and that it loses its quality of blackening hydroquinone upon drying in the exsiccator. I have also observed that the blackening of *Zygnema* never takes place after killing the cells with sulphuric acid or absolute alcohol. *Toyonaga* determined the temperature at which the potato lost its peculiar action upon hydroquinone, pyrogallol, and pyrocatechin, and found it to be 73°. Mercuric chloride destroyed its qualities at 55° in one hour, formic aldehyde (5 %) after 2

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(1) Also the cambial sap of the conifers turns gradually brown in contact with air. The turning brown of blossoms and green leaves which sets in after death, belongs to the same group of phenomena. The existence in plants of oxidising enzymes was recently also shown by *Bertrand* C.r. 120.

(2) Journ. prakt Chem., 88 and 105; *Gmelin-Kraut*, I. 2. p. 456.

(3) Wien. Akad. Ber. 1887.

(4) The compound yielding the colouration of potato juice can be extracted with alcohol; it turns dark brown in contact with Fe Cl_3.

(5) *E. Schöne* (*Z.* analyt. Chem., **33**, 159) observed that *old* guaiacum tincture yields a greenish blue colouration with diastase alone; *fresh* tincture, however, wants the addition of hydrogen peroxide. The substance yielding the blue product is guaiaconic acid, $C_{20}\ H_{24}\ O_5$ (Lücker).

days standing, almost completely; dilute sulphuric acid and caustic potassa acted in the same way, so that there can be hardly any doubt that the active principle is an enzyme.

Oxidising enzymes appear to be present also in the *animal* body. Saliva produces a blue colour with *Wurster's* reagent (tetramethylparaphenylene-diamine), a fact erroneously taken to be a proof of the presence of hydrogen peroxide; it produces further a brown colouration with hydroquinone. *E. Salkowski* found in the blood, *Jaquet* and also *Yamagiwa* in the lungs, kidneys, and muscles, enzyme-like agencies, capable of producing small quantities of benzoic acid from benzyl alcohol and of salicylic acid from its aldehyde.[1] But such actions of enzymes are always of a very narrow compass; they belong to very weak oxidations of certain benzene compounds, but never to an attack upon, to say nothing of a complete combustion of, sugar or fat. We must therefore reject also the theory of *Traube* as wholly unsatisfactory.

It appears singular that the authors mentioned all ignored just the most important condition for respiration, *i.e.*, the *living state of the protoplasm*. Taking a plain chemical start and leaving physiology aside, they endeavored to reach a satisfactory explanation, biased by the idea that the albuminous compounds the chemist studies in his vials are the same as those composing living matter. This erroneous conception still governs the minds of many, and by them respiration will never be comprehended.

It was *Pflüger* who in the year 1876 drew the inference in plain and forcible logic that the proteids of the *living* protoplasm are different from those of the dead, and that their chemical change into the indifferent common proteids signifies the death of the cells. Only those chemical qualities exhibited by the *living* cells can induce respiratory activity. "Oxygen is not made active, but the proteids of the living cells have the activity." Thus, a new foundation was gained, but few physiologists took notice of it; above all, however, *Nencki* assented. *Detmer* modified *Pflüger's* view, assuming a continuous *dissociation*

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(1) Jahresb. f. Thierchem., **22**, 387. Also *Röhmann* and *Spitzer*: Ber. Chem. Ges., **28**, 567.

of the "units of life," whereby respiration would be induced.[1] The dissociation he assumed to be followed by regeneration. This barbarous idea of dissociation, however, would be incompatible with the great sensitiveness of the living protoplasm; dissociation would mean simply death and nothing else.

But how can the living protoplasm, in spite of its extraordinary sensibility, carry on such a powerful combustion process, surpassing in energy the action of nitric acid, without being injured? Can we hold it possible that the oxygen is first activified before it oxidises? It would seem to us that an activified oxygen would have certainly other ways of action than those observed within the living protoplasm. Respiration exhibits like the well studied oxidations by various agents,[2] its own specific manner of oxidising. An animal capable of oxidising in 24 hours several hundred grams of starch (sugar) completely to carbon dioxide and water,[3] is unable to burn up a few grams of oxalic or formic acid.[4] It is even unable to oxidise 1 gram of benzene completely to phenol. And while it destroys tyrosin, quinaldin, and pyrrol, it attacks with difficulty hydroquinon, phenylacetic acid, or naphthoic acid.

A series of investigations by *Nencki*, *Mering*, *Baumann*, *Salkowski*, and others, led to the recognition that certain compounds reappear in the urine unchanged, such as benzidine, others in combination with sulphuric acid, as phenol, others again (partially oxidised or not) as derivatives of glycocoll, like picoline or benzoic acid, or of glucuronic acid, as tertiary alcohols and thymol, or of cystin, as brombenzene; they may also reappear as uramido-compounds like sulphanilic acid, or taurin.

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(1) Physiologie des Keimungsprocesses, Jena, 1880; Jahresb. Thierchem., 22.

(2) Potassium permanganate, nitric acid, hypochlorites, hydrogen peroxide, lead peroxide, silver oxide, have all a specific oxidising action. The results may however sometimes be modified by relatively small changes in the molecules to be oxidised, as by the introduction of an acidic or alkylic radical.

(3) The question as to the intermediary products is of relatively small importance. The formation of glucuronic acid in animals shows that to a very small extent acids are produced, but formic and oxalic acid certainly only in slight degree. The forerunner of carbon dioxide is probably the bivalent group HC-OH, but that cannot be proved.

(4) Oxalate of sodium in non-lethal doses reappears in the urine with a loss of only 7 per cent (*Gaglio*). Sodium formate reappears to the extent of $\frac{1}{2}$-$\frac{2}{3}$ in the urine (*Gréhaut* and *Quinquaud*).

The lateral chains of aromatic ketones are oxidised to carboxyl, if the benzene ring does not contain a hydroxyl-group, otherwise the entire compound will reappear in combination with sulphuric or glucuronic acid in the urine, with the lateral chain preserved (*Nencki*). Some sulphur compounds will yield sulphuric acid, while others will not.[1]

It is, further, of great interest that the oxidation of benzene to phenol and to small quantities of pyrocatechin and hydroquinone in the animal body (*Nencki* and *Giacosa*) is diminished by the introduction of certain poisons.[2]

The difficulty in completely oxidising benzene derivatives of a certain constitution is not only encountered in the animal but also in the vegetal organism. Many plants accumulate tannins and related compounds without ever utilising them again; in most cases they are excreted and may by their repulsive taste prevent depredations by various animals: only under certain conditions may tannin be utilised again.[3] Also certain alkaloids in plants undergo no further metamorphosis[4] and have to be looked upon as excreta. It is, further, very characteristic of the oxidising faculties of plant-cells that certain compounds are left unchanged, which, even by such a comparatively weak oxidising agent as hydrogen peroxide, are attacked readily. Thus, it was observed by *Pfeffer* that cyanin (a quinoline derivative), introduced into plant-cells is not altered, while it is easily bleached by the peroxide. Also certain compounds in the roots of *Vicia* and of *Trianea Bogotensis* are easily converted into brown oxida-

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(1) Compounds of the general formula NH_2—CO—S—R easily yield sulphuric acid; thiophen or sulphonal do not (*Smith*).

(2) *Nencki* and *Sieber* (*Pflüg.* Arch. **31**, 319). found, e.g., that while in the body of a healthy man 0.82 g. phenol was formed from 2 gram benzene, under normal conditions, only 0.33 g. was formed if 2 gr. ethyl alcohol per kilo of body-weight were administered at the same time. Also individual differences were noticed. Poisons may also interfere with *normal* oxidising processes; thus, diamide in non-lethal doses leads to the appearance of allantoin in the urine of dogs (*Borisson*, Z. physiol. Chem., **19**, 499).

(3) Small kinds of Spirogyra will use up their tannin after a few weeks cultivation in a solution containing 0.5 % KH_2PO_4; 0.2 % $KHCO_3$ and traces of nitrate and sulphate of calcium.

(4) Cf. the investigations of *Leo Errera*, Maistriau, and Clautriau, especially those of the latter in the Bulletin Belge de Microscopie, 1894.

tion products by it, while they remain colourless during their stay in normal cells.[1]

How weak the oxidising power of the cells appears to be here and then how energetic when sugar comes under action! We search the entire domain of chemistry in vain for a single case of the occurrence of complete combustion when an organic compound in aqueous solution absorbs oxygen from the air;[2] even the well known energetic absorption of oxygen by alkaline solution of pyrogallol does not lead to a complete combustion. Only the action of free permanganic acid can exhibit similar results.

However, there exist cases where *partial* oxidations by molecular oxygen can easily take place. We will mention the transformation of aldehydes into acids, of hydrazo-benzene to azobenzene, of indigo white into indigo blue. Also the behaviour of anthraquinone, oxindol, and amidophenols to common oxygen may be cited. The total change here taking place consists either in the entrance of one oxygen atom into the molecule or in the withdrawal of two hydrogen atoms. Other compounds again acquire the property of absorbing free oxygen through the presence of an alkali, as pyrogallol, pyrogalloquinone, chrysarobin, furoin.[3] Benzene acquires it by the presence of aluminium chloride. In all these cases there exists evidently a high degree of lability in certain hydrogen atoms leading to the absorption of oxygen. This lability is due to their specific position in the molecules.[4] We observe under ordinary circumstances, however, no labile hydrogen atoms in the fatty acids proper, but nevertheless the latter are easily burned up in the cells. We must then logically conclude that *contact with the living protoplasm* suffices to impart a state of lability to the atoms in the molecules of the fatty acids, recalling the action of

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(1) Ber. Sächs. Akad. d. Wiss., 1889, p. 493. These observations likewise proved the absence of H_2O_2 in plant-cells.

(2) It is obvious that the energetic autoxidation of zinc ethyl, dimethyl arsine, monobrom-acetylene and of the sodium compounds of ketones and aldehydes, which burst into flame in contact with air cannot serve for comparison.

(3) A preliminary "activifying" of oxygen takes place here just as little as in the living protoplasm.

(4) Lability of hydrogen linked to carbon may be of two kinds: one which determines its easy exchange by certain metals, as in acetylene, the other which causes its increased affinity for oxygen, as in aldehydes.

platinum-black, which renders the alcohol molecule so labile that it readily takes up oxygen. We must look upon both kinds of phenomena as *katalytic oxidations* (cf. the foregoing chapter).[1]

It is the CH_2— group in the fatty acids and amido acids, and the CH OH— group in ketoses, aldoses, and hydroxylated acids that are most easily attacked. The carboxyl-group renders the CH OH— group in a molecule much more easily attackable than does the alcoholic group CH_2 OH. Thus, we see that glycerol and mannitol are (at least in the animal) by no means easily oxidised, while, *e.g.*, tartaric acid is. The influence of the carboxyl-group also becomes evident when we compare the bibasic phthalic acid with the monobasic benzoic acid; the latter resists while the former is for the greater part burned up. That in the animal the amido-acids (leucin, glycocoll, tyrosin) undergo combustion with especial facility, yielding thereby urea was demonstrated by *Nencki* and *Schultzen*, as early as 1872, and later on by *Knieriem*, *Schmiedeberg*, *Weiske*, and *Lewinsky*, in experiments with asparagin. *Nencki declared, therefore, the amido-compounds to be the forerunners of urea.*[2] This view, which does not assume a *direct oxidation* of dissolved proteids, but a previous splitting into a group of well known amido-acids, is very well supported by observations of *Hofmeister*, which prove with what difficulty peptone, *as such*, is oxidised in the living animal. A rabbit of 1.75 kilo. in weight, discharged, after intravenous injec-

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(1) *Nencki* and *Sieber* have tried to determine the extent of oxidation which sugar and albumin can undergo if exposed at 36° in *alkaline* solution to air, and have found it to be very slight. How little the protoplasm itself participates *directly* in the oxidation process may be illustrated by the fact that 95 per cent of the matter oxidised may be sugar and only 5 per cent proteids; with bees the percentage of the latter is still less.

(2) The amido-acids from proteids are even more quickly oxidised in the cells than the carbohydrates, as must be concluded from investigations by *Kumagawa*, who nourrished dogs with an *excess* of lean meat and observed that under this condition also the glycogen of the meat was deposited as fat in the animal (Mittheilungen der medic. Facultät, Tokyo). It is, moreover, of great interest to observe how the production of urea is influenced by the chemical constitution: negative groups connected with the nitrogen will prevent the formation of urea, as *Nencki* has shown with acetamide, recalling the resistance of hippuric acid. But taurin and sarkosin are also oxidised with difficulty, reappearing as uramido-compounds in the urine (*Salkowski*). Urea must be considered as a synthetical product from carbamic acid and ammonia (*Drechsel* and *Abel; Nencki* and *Hahn*).

tion of 0.318 g. peptone, over $\frac{4}{5}$ of it again in the urine, and after subcutaneous injection about $\frac{2}{3}$. Trypsin, present in minute quantities in all parts of the body, may gradually form amido-acids from the circulating protein; also decompositions of another kind may simultaneously take place, whereby sugar is one of the products, which process can not only occur in the liver but also in the milt and kidneys (*Lepine* and *Metroz*). The great amount of urea discharged a few hours after a meal may be due mostly to the amido-acids formed by the pancreatic juice from a part of the proteids of the food.

The view of *Nencki* is further supported by observations in plants. In all cases where the proteids are attacked in plants to support respiration, a previous formation of amido-acids takes place, whose residues are finally found in form of asparagin (cf. Chap. V)[1]; a synthetical product corresponding to the urea of animals.

The view here taken as to the cause of respiration, corresponds in its principal feature to the definition *Nägeli* gives of oxidising fermentation.[2] This author says: "the specific state of motion in the living protoplasm of the mycoderma cells is extended simultaneously to the alcohol and to the oxygen molecules. If, thus, the equilibrium is disturbed to a certain extent, chemical change takes place by aid of chemical affinities." This theory, however, is still imperfect, as it does not show how the "specific state of motion" in the protoplasm is caused and does not define whether it consists of a molecular or of an atomic motion.[3] The new theory which assumes a *chemical difference* between the proteids of the living and those of the dead protoplasm furnishes the key to the "specific state of motion;" it infers from physiological facts (cf. Chap. V) the presence of highly labile atomic groups, viz., aldehyde- and

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(1) Asparagin must be defined as the form in which ammonia is stored up in plants, whether it be formed by decomposition of proteids and amido-compounds or it be resorbed from tbe soil. Cf. *Kinoshita*, this Bulletin.

(2) Theorie der Gärung, p. 43.

(3) *Nägeli* published his "Theorie der Gärung" in the year 1879. A few years later, I often had discussions with him concerning the difference between living and dead protoplasm, which he had taken for a physical and anatomical one. Later on, however, he agreed that there must exist a *chemical* difference.

amido-groups in the molecules of the active proteids, a conclusion supported again by toxicological observations (cf. Chap. III), and by the study of the active reserve albumen in plants (cf. Chap. IV). The actions of this peculiar energy, so well adapted for transmutation into chemical work, were characterised in Chap. VI.

It remains therefore only to explain how the intense and ceaseless oscillations going on in the protoplasm can excite the atoms in the sugar or fat[1] to such energetic motions that a combination with oxygen will result. In this regard it will suffice to point to the action of *heat*, which, at a certain temperature, will bring about the combustion of various compounds.[2] The increased *molecular* motion passes partially into *atomic* motion, rendering the atoms very *labile*, *i.e.*, imparting to them intense oscillations, whereby the chemical affinities originally governing the molecules are loosened, leading to an increased affinity for oxygen. As cohesion is loosened by heat, so the atomic cohesion, *i.e.*, the affinities in a molecule, are loosened by plasmic energy; in both cases atomic oscillations are inaugurated leading to combustion, with the main difference that plasmic energy can accomplish its effect at a much lower temperature than heat energy. When the wave impacts originating from the labile atoms in the protoplasm have fallen upon the atoms of the respiratory fuel, and have led finally to motions of a certain intensity, the act of combustion sets in with great vigour, not a *previous*, but a *simultaneous* splitting up of the oxygen molecule taking place: *normal respiration*. But if molecular oxygen is absent, then such "activified" sugar molecules will undergo other changes, with the production of fat, lactic acid, or alcohol; these processes are

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(1) Fats *as such* can hardly serve for respiration, not being soluble in aqueous fluids. It was therefore supposed that a previous *saponification* is necessary. It is however, much more probable that a conversion of the neutral fats into *lecithin* takes place, which swells up easily in water and is even a little soluble in it. Cf. *O. Loew*, On the physiological functions of phosphoric acid, Biol. C. **11**, 270.

(2) A previous "activifying" of the oxygen is here never noticed, for the small amount of ozone formed by rapid combustion under certain circumstances is only a by-product. Cf. *O. Loew*, On the formation of ozone in rapid combustion, American Journal of Science, Vol. 49.

accompanied by a development of carbon dioxide, and have received the name : *intramolecular* respiration.[1]

If the amount of respiratory fuel decreases, the intensity of respiration will diminish also, and finally, the active proteids of the living protoplasm will, on account of their lability, themselves take up oxygen. And if in a cell a small amount of protoplasm has thus been changed, the equilibrium of the entire tectonic will be disturbed and a rapid chemical change will follow the contraction : *death by starvation.* The protoplasm, however, as if endowed with intelligence, understands how to avoid this dangerous result. It absorbs food and instead of itself taking up oxygen, throws it upon the "activified" molecules of food and thus derives the greatest profit to itself, the liberated energy being utilisd for various vital functions. A great part assumes the form of heat and is dissipated, another part that of mechanical activity, another, again, serves to *increase the original plasmic energy* and leads thus to the most wonderful chemical performances.

But the increased state of lability will lead in turn to an increased respiration, and this, again, to an increased lability. Thus the temperature would continuously rise also, and another dangerous point would be reached: *death by heat*, at 45-50°C. The increased motions of the labile atoms would facilitate the reaggregation into stable position, the passage into *passive* proteids by the action of the labile groups upon each other; we may define this death as caused by an intramolecular self-poisoning. However, there exist, again, conditions to prevent this result, heat being lost by conduction, by radiation, and, further, by evaporation of water. Higher animals also enjoy the benefit of regulating contrivances in the nervous system. It is, nevertheless, admirable to see how close the temperature of *birds* is kept to that dangerous degree which, like an abyss, separates life from death. And still more remarkable are the

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(1) The view of several authors that the so-called *intramolecular* respiration is the primary cause of normal respiration has been refuted as erroneous by *Sachs*, *Diakonow*, *Godlewski*, and others. In most organisms absence of oxygen acts detrimentally, but in cold-blooded animals and plants much more slowly than in warm-blooded animals, while anaërobic microbes and yeasts can do without it altogether.

few exceptions to the general rule, as observed in certain algæ and bacteria, which can remain alive even at temperatures above 90° C.

If we now consider again the general teaching that "the potential energy of the food yields the kinetic energies of the organism," we must keep in mind that there is originally present a certain energy in the living matter, which liberates that energy by combustion, and that *the original energy being thus intensified* leads to the vital functions in the various organs and organisms.

On the Reserve Protein in Plants. II.

BY

G. Daikuhara, *Nōgakushi.*

I have given the results of my investigation on the occurrence of active albumen in a large number of plants in Vol. II. No. 2 of the Bulletin of this College. As all the objects then examined were collected in spring, it seemed to me of interest to examine them during the fall. We know that an extensive transportation of nutritive materials takes place from the leaves to the stem, roots, and bulbs. I supposed therefore that leaves found rich in active albumen in spring might not show this kind of reserve material in autumn. On the other hand, it seemed also possible that plants of rapid growth and yielding none of the reactions of active albumen in summer might yet accumulate some active albumen late in autumn when development stops.

I wanted also to test the leaves of evergreen plants in the fall, as well as a number of fruits. Accordingly, all the objects here mentioned were examined during the months of October, November, and December. The general result of this examination has been that objects not showing any active albumen as reserve-material in spring also show none in autumn ;[1] and that most objects yielding a positive result in spring, yield the same in autumn, although usually to a much less extent.

I have also repeatedly examined leaves partially dead, as shown by their brown and yellow spots, and could never produce proteosomes with caffeine in the brown parts, but always in the still healthy and green cells, even at points very close to the dead portions. In a few cases I could see, without caffeine treatment, bright globules in the cells, which in some in-

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(1) As examples of those which give no reaction in spring, and do give one in autumn, I will mention the leaves of *Deutzia Sieboldiana*, *Diospyros kaki*, and *Salix japonica*. It should be mentioned here that sometimes the caffeine reaction does not set in immediately, especially in the case of thick cell walls, and can then be detected only after the prolonged action of a saturated caffeine solution.

stances proved to be fat.[1] In one case, however, viz., in the epidermis of the midribs of the leaves of *Osmunthus Aquifolium*, they resembled *impure* proteosomes, and were changed and even partly dissolved by alcohol of 20 per cent.

The frequent occurrence of active albumen in different parts of the *flower* may have an important physiological relation to the formation of seeds. However, the seeds and fruits investigated showed active albumen only in the epidermis in most cases.

A phenomenon which resembles, to a certain extent, the formation of proteosomes is plasmolysis. *Th. Bokorny* has already observed (*Pringsheims Jahrb.* Vol. 20) that *by the action of caffeine* both, normal and anomalous plasmolysis, can take place, whereby the tonoplast can become divided into two or more parts keeping their globular shape for some time. According to his theory, these phenomena have to be explained in the same way as the formation of proteosomes, viz., as being caused by the separation of a certain amount of water of imbibition. It was therefore a matter of particular interest to me to observe such phenomena myself in a number of cases: as, for instance, in the petals of *Ipomœa hedracea*,[2] the leaves of *Camellia theifera*, and the leaf-veins of *Pyrus Toringo*.

The two kinds of globular formation may, however, be easily

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(1) I would here supplement what I have said (*loc. cit.*) upon the use of alcohol and ether to distinguish proteosomes from fat globules. In order to preserve the globular shape of the former, treatment with 1 p.m. NH_3 or with alcohol of 20 % is necessary, before the mixture of alcohol and ether is applied. In certain cases the ammonia has to be diluted to ½ p.m. because of the gradual solvent action of more concentrated solution.

The caffeine proteosomes are, in exceptional cases, not solidified into bright globules, by the action of dilute ammonia, but are partially or, in some cases, (*Acer palmatum*) wholly dissolved. This is evidently due to the presence of a large amount of impurities (tannin especially) in them. The petals of *Pæonia* yield caffeine proteosomes, which are turned by ammonia into hollow globules without any brightness. There exist evidently many differences between the active albumen of some species, and that of others, *e.g.*, many isomers and polymers are possible.

(2) Accompanied by comparatively few proteosmes, and only observed in the lower colourless part, not in the upper coloured part of the petals, after treatment with caffeine.

Anomalous plasmolysis by 0.5 % caffeine solution can also be sometimes observed in *Spirogyra*, after it has been cultivated, for some time, in a 1-5 per mille nutrient fluid.

distinguished by treatment with 1 p.m. ammonia, by which the forms of true proteosomes are not changed,[1] while the tonoplast loses its globular shape.[2]

Another reagent for distinguishing the two kinds of globules is iodine solution, which produces vacuoles in the true proteosomes, while it only causes the tonoplasts to shrivel up.

The results of my examinations are shown in the following tables :

Species.	Objects tested.	Active albumen.	Remarks.
RANUNCULACEÆ.			
Pæonia albiflora, Pall.	Old leaves	Much	Even present in those living cells that were near brown dead portions of the leaves.
Anemone japonica, Sieb. et Zucc.	Flowers	None	
,, ,,	Leaves	None	
BERBERIDEÆ.			
Nandina domestica, Thunb.	Old leaves	Present	
,, ,,	Epid. of fruit	Moderate	
TERNSTRŒMIACEÆ.			
Camellia japonica, L.	Epid. of old leaves	Little	Leaves suffering from albinism also gave the reaction.
,, ,,	Midribs	Very much	
,, ,,	Epid. of fruit	,, ,,	
Camellia Sasanqua, Thunb.	Epid. of fruit	Very much	
,, ,, ,,	Leaves	,, ,,	
,, ,, ,,	Flowers	,, ,,	
Camellia theifera, Griff.	Epid. of fruit	Much	Small fat globules present.
,, ,,	Flowers	Moderate	
Ternstrœmia japonica, Thunb.	Leaves	Moderate	Also present in the reddish portion of the leaves.

(1) They merely solidiy and seem to shrink a little.

(2) In some cases, however, it is well, *after the ammoniacal treatment*, to apply 10 % acetic acid under the microscope, which does not affect the solidified proteosomes, but destroys the globular shape of the tonoplast. I applied this treatment in the case of the petals of *Ipomœa hedracea*.

MALVACEÆ.

Species.	Objects tested.	Active albumen.	Remarks.
Hibiscus syriacus, L.	Flower	None	Starch present.
Hibiscus rosa-sinensis, L.	Flower	None	
,, ,,	Leaves	None	

GERANIACEÆ.

Oxalis rosea, Jacq.	Flower	None	Strong acid reaction.
,, ,,	Leaves	None	

CELASTRINEÆ.

Celastrus articulatus, Thunb.	Epid. of fruit	No decisive reaction	Contains many fat drops.

SAPINDACEÆ.

Acer palmatum, Thunb.	Epid. of leaves	Little	
,, ,,	Epid. of veins	Very much	

LEGUMINOSÆ.

Phaseolus radiatus, L.	Leaves	None	Much soluble passive albumen.
Wistaria chinensis, Sieb. et Zucc.	Leaves	None	No passive albumen in solution.

ROSACEÆ.

Species.	Objects tested.	Active albumen.	Remarks.
Prunus persica, Benth et Hook	Old yellow leaves	Present	Very little in the epidermal cells and moderate qt. in the pallisade cells.
Prunus Pseudocerasus, Lindl.	Old yellow leaves	Present	
,, ,,	August flower	Little	
Prunus Mume, Sieb. et Zucc.	Old yellow leaves	Present	Only in the pallisade cells.
Pyrus Toringo, Sieb.	Young leaves	Little	
,, ,,	Veins of leaves	Very much	In some cells there was produced anomalous plasmolysis.
,, ,,	Epid. of fruit	None	
Rosa laevigata, Mich.	Epid. of fruit	None	
Rosa indica, L.	Leaves	None	
,, ,,	Flower	Very much	
Photinia glabra, Thunb.	Epid. of leaves	None	
,, ,,	Spongy tissue of leaves	Little	

SAXIFRAGEÆ.

Deutzia crenata, Sieb. et Zucc.	Leaves	Very much	No passive albumen in solution.
Astilbe chinensis, Maxim.	Leaves	None	

LYTHRARIEÆ.

Lagerstrœmia indica, L.	Flower	Very much	
,, ,,	Epid. of fruit	Very much	
Punica Granatum, L.	Epid. of fruit	Very much	

BEGONIACEÆ.

Species.	Objects tested.	Active albumen.	Remarks.
Begonia Evansiana, Andr.	Flower	None	
,, ,, ,,	Leaves	No decisive reaction	

ARALIACEÆ.

Aralia cordata, Thunb.	Leaves	Little	
,, ,,	Epid. of fruit	Little	

CAPRIFOLIACEÆ.

Sambucus racemosa, L. var. Sieboldiana, Miq.	Leaves	Present	Many fat globules present also.

EBENACEÆ.

Diospyros kaki, L.	Old leaves	Much	No passive albumen.

OLEACEÆ.

Osmunthus Aquifolium, Benth. et Hook.	Flower	Moderate	
,, ,,	Epid. of veins	Little	
,, ,,	Leaves	None	

CONVOLVULACEÆ.

Ipomœa hedracea, L.	Leaves	None	Even in midribs no caffeine reaction during flowering.
,, ,,	Petals of flower	Present	Only in large cells near spiral vessels. Anomalous plasmolysis also produced.
,, ,,	Stamens of flower	Present	Also anomalous plasmolysis produced, by caffeine.

SOLANACEÆ.

Species.	Objects tested.	Active albumen.	Remarks.
Solanum Melongena, L.	Flower	None	
,, ,,	Leaves	None	Little passive albumen in solution.
,, ,,	Epid. of fruit	None	
Nicotiana Tabacum, L.	Leaves	None	
,, ,,	Flowers	None	
,, ,,	Epid. of seeds	None	

POLYGONACEÆ.

Polygonum tinctorium, Lour.	Flowers	Very much	
,, ,,	Leaves	None	

CUPULIFERÆ.

Quercus glandulifera, Bl.	Leaves	Little	
,, ,,	Midribs	Much	

SALICINEÆ.

Salix japonica, Thunb.	Leaves	Very much	

SCITAMINEÆ.

Canna indica, L.	Flower	Much present	

On the Consumption of Asparagine in the Nutrition of Plants.

BY

Y. Kinoshita, *Nōgakushi.*

The fact that asparagine is formed whenever proteids undergo decomposition in plants has been repeatedly made the subject of close investigation by various authors, but much less attention has been hitherto paid to the reverse process—the regeneration of proteids from asparagine. *C. O. Müller*[1] has asserted that this regeneration can only take place during the process of assimilation in green leaves, and that the action of light and the *status nascens* of carbohydrates are essential. As this statement did not appear to me to be well-founded, quantitative investigations being wanting, I undertook a series of experiments in order to see whether this process might not proceed in the dark.

If we look upon the growing root from the physiological point of view, we must hold it highly probable that the cells of the root, although always deprived of light, are capable of forming the proteids necessary for its growth and development from suitable sources, such as sugar, nitrates, and sulphates, or sugar, asparagine, and sulphates. It is a well known fact that mould fungi can form their proteids in this way, in complete darkness, and that certain fungi, especially bacteria, grow even much better in the dark than in day-light; it may, therefore, be surmised that the formation of proteids and protoplasm may also proceed better in darkness.

The *relative amount of glucose*, or other suitable material, seemed to me the most decisive factor in the transformation of asparagine into proteids. I, therefore, selected shoots of soya-beans, which are rich in asparagine, and tried to nourish them with organic materials, repeatedly making microscopical tests, in the usual way, with alcohol, as described by *Borodin*, *Pfeffer*,

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(1) Ein Beitrag zur Kenntniss d. Eiweissbildung in der Pflanze. Landw. Versuchst. Bd. 33, p. 11.

and others, and finally determining the amount of asparagine still present, by crystallisation, according to *E. Schulze's* method.[1] Either methyl alcohol, glycerol, or glucose was used as organic nutrient, in solution along with calcium sulphate.[2] Every seventh or eighth day, this solution was replaced for a day by one containing 0.5 per mille each of the two potassium phosphates, and of hydrated magnesium sulphate, so as to furnish the necessary mineral matters. The cotyledons were cut off at the beginning of the experiment, in order to prevent further formation of asparagine by decomposition of the reserve proteids. A control experiment was made at the same time with soya shoots kept in water, in which an asparagine determination was made just before the other shoots were placed in their nutrient solutions, and again in others at the time when the shoots under investigation were analysed.

The soya-beans were soaked in water on March 7th, sown on moist saw-dust next day, and kept in the dark. In four days, at rather low temperatures, the seeds had germinated and the roots had reached the length of 2-3 cm. At this time I tested the tips of several roots microscopically for asparagine and found only doubtful traces; but when the roots had become 6 cm. long the presence of a moderate quantity was easily recognised. At this time the young plants were placed in water on a wire net.

After the length of the entire plants had reached 20-27 cm. and the stem and the root had been found to be rich in asparagine, by microscopical tests, a portion of the shoots was placed on April 1., (*a*) in a 1 % solution of methyl alcohol mixed with $\frac{1}{10}$ of its volume of saturated gypsum solution, (*b*) in glycerol[3] solution of 1 %, with gypsum, and (*c*) in glucose solution, the cotyledons of all the shoots having now been removed.

Whenever the solutions became turbid from bacterial growth, they were renewed at once. When the hypocotylous part of the stem had reached about 30 cm. in length, growth seemed

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(1) Landw, Jahrbüch., 1888, p. 688 and 701; also 1880, p. 14.

(2) In some trials I made use of sodium acetate and tartrate, but not with satisfactory results, perhaps because the conditions were not favourable.

(3) Preliminary experiments had convinced me that a solution of 10 % or even of 5 % glycerol is not adapted for the further development of the plant. Indeed, in the 10 % solution the shoots died after 2 days.

to stop in it, while the growth of the shoots above the cotyledons was now more marked than before. It may be mentioned that most of the leaves of the shoots cultivated in glycerol solution were somewhat larger than those grown in methyl alcohol. Microscopical examination exhibited now a very great difference between the amount of asparagine present in the control shoots, and that present in the other cases. Direct tests for the presence of dissolved reserve albumen, made upon an aqueous extract by addition to it of nitric acid, showed that there was none present in the control case and much present in the shoots cultivated in sugar and glycerol. We see, therefore, that the decrease of asparagine is coincident with an increase of the dissolved proteids. Microscopical tests made it further highly probable that the amount of other amido-products was continuously decreasing, while tests for sugar with Fehling's solution revealed its presence in the shoots grown in glycerol, but neither in those grown in methyl alcohol nor in the control case.

Soon afterwards, on April 27th, a final measurement of dimensions, and a quantitative determination of asparagine were made. The stem without the hypocotylous part had a length of 4-14 cm., in the control case No. 2; a length, of 11-19 cm. in glycerol, and of 8-19 cm. in methyl alcohol.

The quantity of asparagine was as follows:

	Date of determination.	Dry matter in grammes.	Asparagine in grammes.	Asparagine per cent in dry matter.
Control shoots No. 1.	April 1st.	3.966	0.853	21.5
,, ,, No. 2.	,, 27th.	2.948	0·847	28.7
,, ,, No. 3.	,, ,,	3.611	0.906	24.0
Shoots in methyl alcohol	,, ,,	2.698	0.511	18.9
,, ,, glycerol(1)	,, ,,	4.590	0.629	13.7

(1) For determining the amount of asparagine in those shoots which had been kept in the dilute glucose solution, the material was not sufficient, but I microscopically examined the shoots for asparagine on the 8th May, (when some of the leaves showed brownish spots, indicating a gradual decay), and found a not inconsiderable amount of it still present. I do not doubt that if we could introduce more concentrated sugar solution into the cells of the shoots, the shoots would continue to grow in the dark until all the asparagine had been transformed into proteids or protoplasm, provided the necessary mineral salts had been also introduced.

The determination of asparagine in the control shoot No. 1, was made after the removal of the cotyledons (April 1), when the experiment proper commenced. If we compare this result with that yielded by the control shoot No. 2, we find an increase of asparagine in percentage of dry matter, due probably to the gradual conversion of other amido-compounds into asparagine.[1] The fact that in the control case No. 3, where the cotyledons had not been removed, a smaller percentage of asparagine was found than in No. 2, may probably be due to the galactans and other carbohydrates gradually becoming soluble and getting consumed in support of respiration, thus protecting proteids as well as amido-compounds from further changes, and retarding the production of asparagine.

The principal conclusions which we can draw from the results obtained are:

(1). Glycerol and methyl alcohol supplied by the roots, can not only hinder the production of asparagine in the shoots, but are also capable of diminishing the amount already formed.

(2). Glycerol is much more effective than methyl alcohol. It also forms sugar in the cells.[2]

(3). Since shoots have been found to grow better in solutions of methyl alcohol and glycerol than in water, and also to show the presence of dissolved proteids by the nitric acid test, it is safe to assume an increasing protein production in the shoots thus nourished; in other words methyl alcohol, as well as glycerol, can serve for the regeneration of proteids from asparagine, and as this process can go on in *perfect darkness,* light must be denied to have any *direct* action in supporting it.[3]

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(1) Compare *O. Loew.* This Bulletin, Vol. II. No. 2.

(2) This formation of sugar is in accordance with the observations of *Laurent*, *Ar. Meyer*, and *Th. Bokorny*. The latter author has also observed starch formation from methyl alcohol under the influence of daylight.

(3) It is however indirectly of great importance, because it yields the necessary carbohydrates; for the more sugar there is present in a cell, the quicker will asparagine be transformed into proteids.

On the Assimilation of Nitrogen from Nitrates and Ammonium Salts by Phaenogams.

BY

Y. Kinoshita, *Nōgakushi.*

There exist many observations on the development of plants, as to whether nitrogen is supplied in the form of nitrates or in that of ammonium salts. One would naturally expect that ammonium salts would be the better source of nitrogen, because nitrates would have to undergo reduction to ammonia before assimilation proper (formation of proteids) could take place, thus causing not only loss of time, but also the waste of such organic material (most probably glucose) as serves for this reduction. But, contrary to expectation, nitrates have been found in many cases to act more favourably than ammonium salts. This result may be due to the noxious qualities which ammonium salts have in a higher concentration than that immediately needed in the cells. Nitrates can be stored up in roots and stems, but ammonium salts cannot. The question, therefore, presents itself, as to the form in which the nitrogen of ammonium salts is stored up, when these salts are absorbed in greater measure than that required for the immediate wants of the plant.

Asparagine has been frequently found in the roots and bulbs of many plants, but it has not been positively ascertained yet, whether this compound is in these cases a decomposition product of proteids, as it is in germination, and in the starvation of plants kept in the dark. Some authors have assumed that this asparagine is formed in the leaves by the action of nitrates upon carbohydrates, and is then transported to the roots, while others have supposed its synthetical formation in the roots, leaving entirely unsettled whether nitrates, or ammonium salts, or both, equally well contribute to its formation.

I have, therefore, made several experiments to decide under what conditions the formation of asparagine is brought about, and whether also its formation takes place in the dark, that is, without the reducing action exerted by light in leaves. For these experiments, I selected such plants as are rich in starch and which form, therefore, under ordinary conditions, but very little asparagine by the decomposition of proteids.

Barley seeds were distributed in three pots, filled with moist sand, and kept in the dark. After sixteen days the height of the young plants was, on an average 20 cm., but their tips began to dry up gradually. At this time, I subjected the plants of one pot to analysis, while the second pot was treated with a 1 % solution of ammonium chloride, and the third with an equivalent quantity of sodium nitrate. Of each of these solutions, 0.5 litre was administered at three different times. After one week, the growth was found rather insignificant, and the drying at the tips had extended.

After the sand had been carefully separated by washing, the whole plants were analysed. Not a trace of ammonia could be discovered in them, in spite of their treatment with ammonium chloride. The total nitrogen was determined by *Kjeldahl's* method, the protein nitrogen by that of *Stutzer*, and the asparagine by that of *Sachsse*.

The result was as follows :—

Date	15th May	22nd May	
Plants in	water,	amm. chlor.	sod. nitr.
Total nitrogen	3.512	4.436	4.925
Protein nitrogen	2.704	2.126	2.066
Nitrogen in asparagine[1]	0.656	2.027	0.977

A very great difference is here seen in the quantity of asparagine, its production being favoured by ammonium salts.

In a second experiment, young maize of nearly 40 cm. in height was placed with its roots in solutions of sodium nitrate and of ammonium nitrate, both containing 0.1 % of nitrogen, while the control plants were placed in distilled water. After

(1) No especial attention was paid here to the other amido-compounds, which evidently must have been present in all three cases.

four days' standing in diffused day-light, the whole plants were subjected to nitrogen determination, with the following result :—

Plants in	water,	amm. nitr.	sod. nitr.
Total nitrogen	4.13	4.23	4.15
Nitrogen in asparagine	0.38	0.73	0.24

From this it is evident that ammonium salts are transformed into asparagine, while nitrates can be stored up as such. The difference would have been found still greater in the latter case had only roots and stems been tested, and I think it safe to assert that asparagine is the form in which the excess of nitrogen, originally in the ammonium salts, is stored up in the plants, although I regard these investigations merely as a preliminary step to a longer series I intend to carry out in order to decide whether my conclusion can be substantiated.

On the Presence of Asparagine in the Root of Nelumbo nucifera.

BY

Y. Kinoshita, *Nōgakushi.*

The root of *Nelumbo nucifera* is used in this country in the boiled condition as food, and is rich in starch. Its nutritive quality may be judged from the following analysis by *Kellner:*

Water	85.84 %

In 100 pts of dry matter:

Crude protein	7.75
Fat	1.44
Fibre	7.19
Non-nitrogenous extract, starch etc...	78.59
Ash (free from carbon and carbon dioxide) ...	5.03

I suspected that a certain amount of nitrogen might be present in the form of amides as in potatoes and beets, and actually found the presence of a not inconsiderable quantity of asparagine. This substance is evidently closely connected with the formation of proteids, and is therefore of high physiological interest.

It has been frequently found in germinating seeds, which contain the more of it the poorer they are in carbohydrates. It is also present in many buds during their development, but its presence in roots has less frequently been demonstrated. The root of *Althæa* contains 2 %, that of *Glycirrhiza* (*Plisson*) 0.8 %, that of *Scorzonera* (*Gorup*) 0.6 %, and potatoes 3 % (*E. Schulze*). It was also found in the root of *Symphytum* and in that of *Lactuca*.

In order to obtain asparagine from the root of *Nelumbo nucifera*, I proceeded as follows:—

The fresh root was reduced to a fine pulp and pressed, the residue was mixed with a little water and pressed once more. The filtered liquid was evaporated and the residue was extracted with hot alcohol of 60 %. Upon cooling an abundant crop of crystals was obtained while the mother liquor yielded more

crystals, on treating it again with hot alcohol and evaporating. An approximate determination showed that this root contains asparagine amounting to nearly 2 % of the dry matter.

The purified crystals showed not only the same crystalline forms as asparagine but also yielded up one molecule of water when dried at 100°, while the nitrogen determination according to the method of Kjeldahl also agreed with that for asparagine. For the determination of nitrogen, I took 0.3 gr. of the substance dried at 100° and obtained 0.06232 gr. nitrogen, that is 20.78 %.

	Calculated.	Observed.
Water of crystallisation	12.11 %	12.14 %
Nitrogen	21.02 %	20.78 %

The solubility in water nearly agrees with the number given by *Guareschi*, thus:

1 part of asparagine dissolves in 55.86 pts of water at 10.5° (*Guareschi*).	1 part of the substance dissolved in 56.72 pts of water at 11.2°

On the Occurrence of Two Kinds of Mannan in the Root of Conophallus konyaku.

BY

Y. Kinoshita, *Nōgakushi.*

The root of *Conophallus konyaku* has been recently investigated by Mr. *C. Tsuji*, who found that it contains a large amount of an anhydride of mannose, but it was not shown by him whether only one or several polyanhydrides are present. It has been proved, however, that there exist both soluble and insoluble mannans; to the former belongs, for instance, the mannan discovered in yeast, to the latter that found in the nuts of *Phytelephas*. The fact that an aqueous decoction of the *konyaku*-root is so slimy that it serves in this country for technical purposes, as for pasting clothes, etc., made it very probable that some of the mannan is present in the soluble form.

Special experiments have convinced me that, by treatment of the *konyaku*-root with diluted sulphuric acid, neither glucose nor galactose, xylose nor arabinose is formed. The sugar appears to be mannose and nothing else. I could neither obtain mucic acid by its oxidation with nitric acid nor the red pentose reaction with phloroglucin and hydrochloric acid, nor did the filtrate from the mannose-phenyl-hydrazone (prepared in concentrated solution) yield any notable amount of an osazone.

I extracted a portion of the finely ground root repeatedly with boiling water, until the extract had no longer any slimy character. The residue yielded mannose, upon boiling with dilute sulphuric acid, as was ascertained, beyond doubt, by its phenyl-hydrazone. The slimy extract of the root was mixed with alcohol, which formed a copious, almost white, flocculent precipitate, that was filtered off and washed with dilute alcohol. Its solution in water was so opalescent that no test

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(1) This Bull. Vol. II. No. 2.

could be made in regard to its rotatory action upon polarised light. Upon drying at 100°, it lost its solubility in boiling water entirely. Upon boiling with 4% sulphuric acid for several hours mannose was also obtained from it. The property of losing its solubility upon drying proves that this mannan is different from that separated from yeast by *Salkowski*,[1] with which it agrees, however, in the following respects:—

Basic lead acetate—no precipitate; basic lead acetate and ammonia—thick precipitate; ferric chloride and ammonia—gelatinous precipitate; copper sulphate and sodium hydroxide—thick blue precipitate; and the same by Fehling's solution.

It seemed to me of interest to determine whether the diastase of malt, invertase, or emulsin would have saccharifying power over this slimy mannan of *konyaku*, and this I tried and found not to be the case; its slimy character remained, although I digested it with the enzymes mentioned for 5-6 hours at 40°—60°, and no sugar was formed.

That this mannan is also digested with much more difficulty than starch, has been shown by Prof. *Osawa*'s experiments on dogs. An enzyme endowed with saccharifying power for mannan must, however, exist in the *konyaku*-root, and I intend to try to isolate it in the season when the root is in the state of developing shoots.

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(1) Ber. d. chem. Ges., 1894. p. 499.

Note on the Chemical Composition of some Mucilages.

BY

K. Yoshimura, *Nōgakushi.*

The mucilages or saccharo-colloids, hitherto analysed, have been found to consist, in most cases, of saccharo-polyanhydrides of either glucose, galactose, mannose, or arabinose. Only in one case was the mucilage shown to consist of a mucin (*Ishii*, Vol. II. No. 2 of this Bulletin).

Although such compounds are widely distributed in the vegetable kingdom, they have been investigated but in a very limited number of cases. As it is of physiological interest to know the composition of mucilages in as many plants as possible, I have examined those of the following species:

1. *Sterculia platanifolia* (young shoots).[1]
2. *Colocasia antiquorum* (tuberous roots).[2]
3. *Opuntia* (fleshy stem).
4. *Vitis pentaphylla* (stems and leaves).
5. *Œnothera Jaquinii* (stems and leaves).
6. *Kadzura japonica* (young leaves and stems).

The concentrated slimy extracts were precipitated with strong alcohol and the precipitates, after having been washed with alcohol, were boiled with sulphuric acid of 2-4 % for 2-5 hours, the liquid neutralised with barium carbonate, and the filtrate evaporated to a syrup.

A portion of this syrup was evaporated with nitric acid to observe whether mucic acid was formed.

Another portion was mixed with a cold concentrated solution of acetate of phenylhydrazine to observe whether mannose-phenylhydrazone was formed.

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(1) The mucilage of *Sterculia platanifolia*, as well as that of *Kadzura japonica*, finds technical application in this country, being used for sizing paper, etc.

(2) The tuberous rootstock of *Colocasia antiquorum* serves as a valuable food in this country, and is hence cultivated to a large extent.

Another portion was examined with phloroglucin and hydrochloric acid for the presence of pentoses. And, finally, the osazones were made in the usual manner and, after purification by recrystallization from dilute alcohol, their melting points were determined. In this manner, I was enabled to come to the conclusion that the mucilage of *Sterculia platanifolia* consists of a mixture of araban with some galactan, and that of *Colocasia antiquorum*, since it gave neither mucic acid nor the pentose or mannose reaction, but an osazone which was proved to be identical with phenylglucosazone, consists probably only of a polyanhydride of d-glucose.

The mucilage of *Vitis pentaphylla*, as well as that of *Opuntia*, consists principally of galactan, while those of *Œnothera Jaquinii* and of *Kadzura japonica* contain galactan and araban.

The Preparation and Chemical Composition of Tofu.

BY

M. Inouye, *Nōgakushi.*

Wherever rice forms the principal food for man, as in Japan and China, an addition of some other food richer in proteids is necessary to make up the deficiency of proteids in rice.[1] The inhabitants of this country on the sea coast supply this want by the use of marine animals, while the inland people subsist on the seeds of various leguminous plants, especially the soya bean, beef and other kinds of meat having only come into use in recent times. The soya bean is considerably richer in proteids than rice, as may be judged from the following analyses :—

	Rice.[2]	Soya bean.				
		1	2	3	4	5
Crude protein	10.82	38.69	31.21	34.92	33.36	42.05
Fat	2.78	17.87	18.29	15.53	21.89	20.46
Crude fibre..	1.12	12.69	12.78	12.81	—	4.53
Starch..	84.22	3.49	3.51	3.53	—	—
Ash	1.06	5.39	5.63	5.97	5.35	4.19
Other organic matters ..	—	21.01	28.09	26.53	34.18	28.82

(1) Although the proteids of rice are better digested than those of barley, as *Rintaro Mori* has shown, the exclusive use of rice cannot be recommended.

(2) The sample of rice and that of soya bean No. 5 of the above table, were analysed by *O. Kellner* and were products of Japan (Bulletin vol. I, No. 2 and 6). The sample of soya bean, No. 1, was from China, No. 2 from Hungary, No. 3 from France, and analysed by *Pellet* (Chem. C. B., 1880, p. 410). The sample No. 4 was analysed by *Güssmann* (Chem. C. B., 1890, p. 133).

According to the results obtained by *Pellet*, only about 5 % of the entire nitrogen is non-albuminoid, while in the Japanese soya bean, according to the analysis of *O. Kellner* and *Kuroshima*, it amounts to 7.1 %.

Meissl and *Böcker* (Chem. C. B., 1883, p. 619) found that there are no gluten-proteids contained in the soya bean and only very small quantities of amido-compounds. They extracted the beans both with dilute potash and also with 1 % solution of sodium chloride, and found in both cases one and the same proteid, which proved to be a casein closely related to milk-casein and to the legumins of other leguminous plants.

I have confirmed the absence of starch noticed by *Kellner* in the Japanese soya bean, by repeated tests with iodine, while observations made in Europe have shown the presence of a very small quantity of starch granules. The numbers given above by *Pellet* for starch include also dextrin-like bodies, which were closely examined by *E. Schulze*, who found them to consist of two kinds of galactans. He also discovered in them some cane sugar and determined the amount of lecithin to be 1.64 %.

Stingl and *Morawski* (Chem. C. B., 1886, p. 724) found a very active diastatic enzyme, possessed by the soya bean much more largely than by many other leguminous seeds. The digestibility of the bean was determined by *Güssman*. He found that 90 % of the protein present is digestible, 89.8 % of the fat, and 14.5 % of the crude fibre.

The efforts to prepare an easily digestible food from soya beans led to the preparation of *miso* and *natto*, two kinds of vegetable cheese, which were investigated some time ago in the laboratory of this College.[1]

But the most interesting preparation is *tofu*, which consists principally of the protein-matter of the soya bean, and which, according to the investigation of Prof. *Osawa* in Tōkyō, is as easily digestible as beef. This preparation is freshly made every day, and sold in form of tablets about 10 c.m. broad, 2 c.m. thick, and 25 c.m. long, is of snow-white appearance, and of the consistency and taste of freshly precipitated casein of milk, but

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(1) On the preparation of *miso*, by *O. Kellner*, this Bulletin, Vol. I, No. 6. On *natto*, by *Yabe*; Bulletin Vol. II., No. 2.

as there is no trace of bacterial action connected with its preparation, the name vegetable cheese, is certainly not justified. The constituents, as determined by *Kellner*, are as follows:—

Water	89.29
Albuminoids...	4.87
Non-nitrogenous extract	4.35
Ash	0.48

Tofu is also sold in another form, called *kori-dofu*. It is prepared by exposing the fresh *tofu* tablets to the action of frost, under which they shrink considerably, lose water, and become more compact. While fresh *tofu* contains, on an average, 89.02 % of water, *kori-dofu* contains only 15.32 %, in the air dry condition.

The analysis of *kori-dofu* gave me the following results:—

Water	15.32 %
Albuminoids	41.42 %
Fat and lecithin	23.65 %
Non-nitrogenous extract	15.05 %
Cellulose	1.48 %
Ash	3.08 %

The manufacture of *tofu*[1] is conducted as follows:—

The beans are first soaked for about twelve hours in water and then crushed between two mill-stones until a uniform pulpy mass is obtained. This is then boiled with about three times its quantity of water for about one hour, whereupon it is filtered through cloth. This liquid is white and opaque, exactly like cow's milk;[2] while the smell and taste remind one of fresh malt. Upon standing, very fine particles separate on the surface which, under the microscope, can easily be recognised to be small globules of fat. Its reaction is neutral or very slightly acid, but after standing for several days it gives a strong acid reaction, ow-

(1) *Tofu* is manufactured only on a small scale, by people who sell it in their own shops.

(2) Even continued boiling will not bring on coagulation of the milky liquid, but the addition of an equal volume of alcohol yields a flocculent precipitate.

ing to the formation of lactic acid, when the separation of casein takes place exactly as in the souring of milk. The lactic acid was determined by shaking out the filtrate repeatedly with ether, evaporating the ether, and boiling the syrupy sour residue with some water and finely suspended oxide of zinc. The filtrate was evaporated to a small volume and after a few days the crystallised lactate of zinc was collected, dried, and weighed.

Thus, 100 cc. of the milky liquid, that had been left for two weeks in contact with air, yielded 0.13 grm. of lactate of zinc, corresponding to 0,092 grm. of lactic acid.

I also analysed the fresh milky liquid with the following results :—

	Soya bean milk.	Cow's milk.
Water	92.53 %	86.08 %
Albuminoids	3.02 %	4.00 %
Fat	2.13 %	3.05 %
Fibre	0.03 %	—
Ash	0.41 %	0.70 %
Non-nitrogenous extract, including carbohydrates	1.88 %	—
Milk sugar	—	5.00 %

The fat contained in this liquid as well as in the *tofu*-tablets was found to consist partly of lecithin. *Tofu* dried at 100° yielded 26.65 % fat and 4.83 gr. of this fat yielded, after igniting with carbonate of soda and nitrate of potash in the usual way, 0.280 grm. of magnesium pyrophosphate, which, multiplied by the lecithin-factor, 7.2703, corresponds to 2.035 grm. lecithin, amounting to 11.2 % of dried *tofu*, leaving for the genuine fat 15.4 %;[1] more of the latter, therefore, is left in the refuse than of the former.

In the manufacture of *tofu*-tablets from the freshly prepared milky liquid, about 2 % of concentrated brine as it is obtained as mother liquor from the preparation of sea salt, is added with constant stirring, whereupon a flocculent precipitate is soon formed which is separated by means of a cloth filter, slowly

(1) A portion of this lecithin was probably present in the soya bean as lecithalbumin ; comp. *Leo Liebermann*, J. B. f. Thierchemie, 1893, p. 32, and *E. Schulze*, Chemiker Zeitg. 1894, Nr. 43.

pressed, and then cut into tabular shape.[1] I have tried to arrive at a satisfactory explanation of the nature of *tofu*, and have found that the salt-brine does not act by its chloride of sodium, but by the calcium and magnesium salts which are in it; for we can at once obtain the precipitate from the milky liquid if we add a little calcium nitrate or magnesium sulphate,[2] while we can not obtain any separation or precipitation by adding even considerable quantities of sodium chloride or sodium sulphate.[3] However, ammonium sulphate will, as with cow's milk, bring on precipitation, if we add 60 % of it to the milky liquid. This precipitate is so voluminous that the liquid seems to solidify. The peculiar state of the solution of soya bean casein resembles that of milk; thus, if milk is dropped upon porous clay, the liquid will be absorbed by the clay, but the casein and fat will remain on the surface, and the same is observed with the milk from soya beans.[4]

I have analysed a sample of the salt brine used for *tofu* making and found it to contain, besides chloride of sodium, 27.9 % of chloride of magnesium and 7.0 % of chloride of calcium. As casein has decidedly an acid character and is only very little soluble in water in the free state, it seemed most probable that the aqueous extract of soya beans contains a sodium or potassium compound of casein[5] yielding insoluble calcium and magnesium compounds, which constitute *tofu*.

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(1) In this way about one fourth of the total amount of proteid in soya beans is obtained in the *tofu*.

(2) An excess of magnesium sulphate is to be avoided, as it would redissolve the precipitate.

(3) If the liquid is warm and saturated with sodium sulphate, a very slow and imperfect separation may be noticed.

(4) In order to see whether a product similar to Swiss cheese could be obtained from the crude soya casein or *tofu*, I infected 50 grm. of fresh *tofu* with a small dose of pulverised Swiss cheese, and added ten per cent of common salt to the mixture, pressed it in cloth, and allowed it to stand in a moist beaker glass for several months. The product resembled, only to a limited extent, the cheese from milk, but further experiments with addition of small quantities of milk sugar are intended.

(5) I observed that soya bean casein is easily digested by pepsin solution acidulated with 0.2 % hydrochloric acid, without leaving any insoluble residue; in this it resembles human casein, which, according to the valuable investigations of *Wroblewski* (Berne, 1894) yields, unlike cow's-casein, no paranuclein. I found also that peas and horse-beans yield aqueous extracts of similar behaviour to that of soya beans.

I found that, after extracting 100 grms. of fresh *tofu* with 1 % acetic acid, the filtrate contained lime 1.91 % and magnesia 3.82 % of the dry matter of *tofu*. A part of this lime and magnesia may have been present as phosphate in the *tofu*, but another part must have been in it in combination with the casein, as also becomes evident from the different behaviour of *tofu* towards a diluted solution of disodium phosphate. If *tofu* is boiled with a 1 % solution of this salt, the casein goes into solution and soon forms an opalescent liquid, while the calcium of the *tofu* yields calcium phosphate ; if we, however, prepare at first the *free casein* from *tofu* by treatment with very dilute acetic acid and thorough washing, we find that it will be soluble only in traces in disodium phosphate even after prolonged boiling,(1) while it is easily soluble in the carbonate. The free soya bean casein thus obtained will, after complete removal of the fatty matters by alcohol and ether, still give an opalescent solution when treated with dilute potash, showing that the opalescence is due not only to suspended fatty matters, but also in part to the casein itself. Such a pure solution of the potassium compound of the casein behaves towards calcium and magnesium salts exactly like the original liquid from which *tofu* is made.

The results which we arrive at in regard to the preparation of *tofu* is as follows : In the soya beans there are contained compounds of casein with potassium or sodium which are not coagulated by boiling, but which yield with the calcium and magnesium salts of the brine that precipitate of insoluble calcium and magnesium compounds of the casein, which constitutes *tofu*. The separation of *tofu* is therefore not due to coagulation but simply to precipitation.

The great similarity between concentrated extract of soya beans and animal milk is also exhibited by the formation of thin surface films on evaporating it at high temperatures. These films contain not only the proteids of the liquid but also include suspended fatty particles and other impurities which are present in the solution. Such films are prepared in this country by evaporating the extract of soya bean, and when dried form

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(1) Therefore we can safely infer that the solubility of the crude soya bean casein in hot water is not due to the presence of alkaline phosphates.

an article of food called *yuba*. Analyses of the air dry product gave the following results:—

Water	21.85 %
Proteids	42.60 %
Fat	24.62 %
Non-nitrogenous compounds	7.65 %
Ash	2.82 %
Carbohydrates.	*trace*.

Note on *Nukamiso*.

BY

M. Inouye, *Nōgakushi.*

Nukamiso is rice-bran in a state of lactic fermentation, and is used for softening certain vegetables, such as the fruit of the egg-plant and the radish, which are rendered palatable and easily digestible, when left in a large quantity of *nukamiso* for about 24 hours.[1]

Nukamiso is prepared by mixing rice-bran with about four times its amount of hot water and adding 6-10 per cent of salt to the mixture. A small quantity of old *nukamiso* is added in order to give the fermentation an early start. Very frequently also some fish broth is added, whereby the fermentation is considerably enhanced. The mixture acquires gradually a strong acid taste and peculiar smell, and has to be stirred from time to time to avoid the growth of mould fungi on the surface, which would no doubt use up the lactic acid and, by thus rendering the mass gradually neutral, would allow of the growth of putrefactive bacteria, which would spoil the product, more especially if enough salt had not been added. Comparative experiments with one per cent solution of peptone have shown that if the quantity of sodium chloride sinks below 5 per cent, putrefaction can easily set in,[2] while lactic fermentation of a sugar-peptone-solution is not prevented by even 10 per cent of sodium chloride, although it is much retarded.

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(1) The *nukamiso* is not eaten, but is carefully washed off from the articles that have been treated with it.

(2) An addition of 5 per cent sodium chloride to a peptone-solution will retard the putrefaction to such a degree that after about two weeks the amount of ammonia formed is only about $\frac{1}{6}$ that of the control case without sodium chloride. This amount of ammonia would be still less, if some lactic acid were present, as in *nukamiso;* moreover, I may mention that, although an addition of even 8 % of sodium chloride to the diluted peptone-solution will not prevent bacterial growth, *putrid* fermentation is very much retared, if not entirely stopped, by that addition, especially if 0.5 % of lactic acid is still present.

Microscopical investigation of a sample of *nukamiso* revealed numerous bacilli, micrococci, a small kind of yeast in state of gemmation, and some mycelium of mucor. Tested with dilute solution of methyl violet, many bacilli became coloured, and were thus proved to be dead. The iodine-test showed the presence of some still unchanged starch by the blue colouration of many of the particles, and of undissolved proteids by the yellow colouration of others.(1)

Upon chemical examination of the filtrate, I found, (besides lactic acid), peptone, sugar, amido-acids, and slight traces of ammonia, but I could not demonstrate the presence of enzymes. Probably such were formed at first by the action of the bacteria, but as the quantity of lactic acid increased, they must gradually have been destroyed.(2)

Volatile acids were evidently present only in traces, and certainly no butyric acid. Lactic acid was determined by titration with normal soda solution, and found to amount to 2.6 per cent.

The general composition of the sample analysed was as follows :—

Water	75.6 %
Lactic acid	2.6 %
Sugar	3.4 %
Sodium chloride	8.1 %
Proteids, Amido-compounds, Fats, Mineral matters, Starch	10.4 %

My own observation on the fermentation of *nukamiso* has convinced me that there is always simultaneous development of bacilli and of a peculiar small kind of yeast, incapable of producing alcoholic fermentation, and forming a scum, like that of

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(1) An infection from a sample of *nukamiso* of sterilised one per cent peptone-solution containing some extract of meat, showed after one week a great development of bacteria, micrococci, mucor, and small yeast cells.

(2) The filtered liquid from *nukamiso* was neutralised with carbonate of soda and digested at 40° with meat-fibres as well as with boiled starch without any solution being observed.

Saccharomyces mycoderma, on the surface, and that, after a few weeks standing, not only sugar, carbon dioxide, and lactic acid are formed, but also a considerable amount of proteids is dissolved. If, at this time, a plate-culture is made with traces of the liquid, bacterial colonies are observed, that liquefy gelatine, and also colonies of the small yeast already mentioned.(1)

The *nukamiso* is prepared in barrels by almost every family in this country, and is looked upon as indispensable for the wants of the *cuisine.*

The products treated with it acquire a peculiar fine flavour. The greater digestibility acquired is due to softening, and this process is principally due to the death of the cells of the vegetables caused by the lactic acid, which causes them to lose their fullness. This process has here, therefore, the same effect as the treatment with vinegar in the preparation, in western style, of cucumber or lettuce-salads, or in the cooking of vegetables ; but the experience in Japan is that the treatment with *nukamiso* produces a superior result in regard to flavour. It may be that *nukamiso* will gradually find its way into other countries, as our soya-sauce or *shoyu* has done.

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(1) The colonies of a kind of *Aspergillus,* which I observed here, are probably not a normal occurrence ; mucor was not observed in this case.

Preliminary Note on the Sake Yeast.

BY

K. Yabe, *Nōgakushi.*

It has been repeatedly asserted that a fungus related to *Aspergillus* called *Eurotium Oryzæ*, forms conidia, which can bring on alcoholic fermentation. This fungus plays a great part in the manufacture of *sake* on account of its high diastatic properties. Rice infected with that fungus, *i.e.*, *kōji*, is mashed along with freshly boiled rice, whereupon, not only saccharification, but also fermentation gradually sets in. Microscopical examination now reveals the presence of numerous cells of a Saccharomyces, which have the size of the beer yeast, but also frequently are about $\frac{1}{5}$ larger in diameter. We have made several experiments in this Institute in order to see whether this yeast could be transformed into the above named mycelium fungus, and have always failed, from which it is to be concluded that the *sake* yeast is *not a certain stage of development of Eurotium*, but a species quite distinct. We hope to communicate at a later occasion the details of further investigations. For the present, the remarks which follow may suffice as to the behaviour of the *sake* yeast.

This species exhibits its fermentative activity in solutions containing a much higher percentage of alcohol than certain other kinds of yeasts. A small amount of the yeast was suspended in a Pasteur solution (containing a higher percentage of glucose than usual) and quantities, of 10 cc. each, were placed in seven flasks, to which were added 50 cc. of the Pasteur solution, a measured amount of alcohol of known strength, and the necessary amount of water to make the volume 100 cc. The percentage of sugar in the flasks at the beginning was 9.48. After 6 days the sugar was determined by *Allihn's* method in those bottles where the fermentation had been lively, while in others the usual titration method was used. The results are as follows :—

Percentage of alcohol.	Sugar still present.	Remarks.
0	0.024	Yeast multiplied very much.
4	0.098	,,
8	1.649	,,
12	5.459	,,
16	8.636	Multiplied but little.
20	9.254	Multiplied very little.
24	9.450	Any multiplication hardly observable.

We see, therefore, that the yeast was still very active in presence of 12 % of alcohol, and even when there was 16 % some fermentative activity was observed.

A large increase of mineral salts in the solution seems also not to interfere, as is shown by the following results, obtained with Pasteur solution to which increased quantities of sodium chloride had been added.

Percentage of sod. chlor.	Percentage of sugar not fermented after 2 weeks.	Relative fermentative power.
.0	0.0826	99.060
.005	0.0711	99.077
.050	0.0557	99.366
.1	—	—
.5	0.0631	99.281
1.0	0.0655	99.255
2.0	0.0741	99.157
4.0	0.0753	99.132
6.0	0.1087	98.764
10.0	4.3982	48.868
12.0	7.5393	14.287
14.0	8.0580	8.391
18.0	8.6360	1.819
22.0	8.7660	0

Note on the Behaviour of Hippuric Acid in Soils.

BY

K. Yoshimura, *Nōgakushi.*

The manurial effect of urine stands among other things in a certain ratio to its amount of nitrogenous compounds, and to the readiness with which these are converted into ammonia.

Kellner has shown that urea as such is not absorbed by the soil and that surface soil more readily converts it into ammonium carbonate than soil from a certain depth. Uric acid can also readily undergo fermentation, with the production of ammonia and carbon dioxide, and with simultaneous oxidation.[1]

$$C_5H_4N_4O_3+8H_2O+3O=4NH_3+5CO_2+4H_2O.$$

But there exists a considerable amount of nitrogen in still another form in the urine of cattle and horses, viz., as hippuric acid.

About 10 % of the total nitrogen of cattle-urine and about 2 % of that of horse-urine are present in this form. As hippuric acid evidently resists the fermentative action of microbes more than urea or uric acid, it seemed to me of interest to observe the behaviour of hippuric acid in soils.

At first, however, I tested soil in regard to its absorptive power for this compound.

It seemed to me possible that soil rich in hydrated oxide of iron might show some absorptive power, ferric hippurate being insoluble. Two kinds of soils were tested; one, from the farm of this College in Komaba, near Tōkyō, consists of volcanic ashes and loam, and contains about 8 % of humus and 8-11 % of oxide of iron; it has a high absorptive power for ammonia and phosphoric acid. The other, from Tochigi, is of clayey nature; both soils are almost free from calcium carbonate.

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(1) *Sestini.* Landw. Vers. Stat., 38., 157.

100 cc. of a solution of sodium hippurate, containing 0.340 % hippuric acid, were well shaken with 20 grms. of soil from Komaba and filtered off after 24 hours, without washing out the soil. Of the filtrate 50 cc. were evaporated to a small volume and, after addition of some sulphuric acid, shaken with acetic ether. The latter after separation left on evaporating, 0.169 grm.= 0.338 % of hippuric acid. It may, therefore, be concluded that practically none of it was absorbed.

Two experiments were then made with free hippuric acid on both kinds of soils, but no absorptive power could be noticed to any notable extent.

In regard to its behaviour towards fungi, I found that dilute solutions of its sodium salt, containing neutral potassium phosphate and magnesium sulphate, are capable of developing mould fungi and microbes, although this salt must be considered as a poor nourishing material.

In order to see whether the microbes of the surface soil would be more energetic in decomposing sodium hippurate than those of the subsoil, I took portions of soil at different depths reaching to 140 centimetres, shook them with sterilised water, and infected a sterilised solution, containing 1 % sodium hippurate, 0.2 % potassium phosphate and 0.1 % magnesium sulphate. The flasks, plugged with cotton, were allowed to stand from December 29th, 1894, to May 5th, 1895.

From time to time, a few drops were withdrawn by means of sterilised glass tubes and tested with *Nessler's* reagent, and it was thus found that, after two months, the solutions infected with the soil from a depth of 50 centimetres, showed moderate reaction, while those infected from greater depths, showed no trace[1] of it. But, later on, and when the temperature had become warmer, increased vegetation of the microbes was noticed in all the solutions, and by the 4th of May, 1895, a strong ammoniacal reaction was obtained in all of them.

It was interesting to find nitrites absent; only in one flask was a very slight trace indicated by *Griess's* reaction.

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(1) The temperature of the room was, until the end of February, generally lower than 5 degrees C.

Several bottles were examined for undecomposed hippuric acid, but none could be found.

The bacterial vegetation consisted mainly of micrococci.

Results.

Hippuric acid and its sodium salt are not absorbed by the soils tested.

Decomposition of hippurates proceeds more quickly in the surface soil than in the subsoil; this decomposition is attended with liberation of ammonia, and is chiefly dependent upon the action of micrococci.

Note to the Preceding.

BY

Prof. Oscar Loew.

The fact observed by *Yoshimura* that nitrification does not take place in solutions of sodium hippurate is in accordance with other similar observations. The nitrifying microbes, able to assimilate ammonium carbonate, according to *Hüppe* and *Winogradszki*, cannot assimilate ammonium formate, and do not develope well upon ammonium oxalate,[1] as I have myself ascertained. In my experiments, the sterilised solutions contained, (besides 0.5 per mille of one of these salts), 0.5 per mille each of neutral potassium phosphate, and magnesium sulphate, and were infected from a culture obtained from garden soil exhibiting a moderate nitrifying activity. The flasks, holding

(1) The objection that the want of nitrification is not under all conditions a reliable sign of the absence of nitromonas, seems to me not tenable. In those cases, however, in which other microbes are also present, the ammonium nitrite formed can easily be destroyed.

2 liters each, remained for 12 weeks, in the dark at 16-18°. The fungoid mass which formed was exceedingly small and hardly visible. While there was no nitrite formed in the flask containing the formate,[1] there was some in the oxalate flask. A small portion of this liquid was diluted with 9 times its volume of water, and the coloration obtained by *Griess*'s reaction compared with that of standard, highly diluted nitrite solutions. In this way, the conclusion was arrived at that the total amount of nitrous acid did not exceed one milligramme, while the control solution with ammonium carbonate contained more than 10 times as much. I observed further that the nitrification-process proceeds nearly double as quickly in the dark as in the daylight.

(1) There exists however a certain bacillus—I have called it *Bacillus methylicus*- able to assimilate formates (Centrbl. f. Bact., **12**, Nr. 14).

Does Hydrogen Peroxide occur in Plants?

BY

J. Cho.

It had been often stated that hydrogen peroxide in small quantities occurs in plants, but it was shown by *Th. Bokorny*[1] and also by *W. Pfeffer*,[2] that these statements are not well founded. Quite recently, however, it has again been asserted to do so by *A. Bach*.[3] After he had tried all known reagents and had found them to be insufficient for proving the presence of very small quantities of hydrogen peroxide in plants, he employed a new reagent which, indeed, may prove useful in certain cases.

This consists of a highly diluted mixture of potassium bichromate with free aniline.[4]

The liquid to be tested has to be mixed with an equal volume of this reagent, in presence of a little oxalic acid. If a trace of hydrogen peroxide is present, a violet coloration is produced, due to the action upon aniline of perchromic acid, intermediary formed.

I have convinced myself of the delicacy of this interesting reaction. *Bach* employed it in examining twenty-five species of plants, of which eighteen yielded a positive result. He says,

> "Sur les vingt-cinq espèces végétales examinées, les dix-huit suivantes ont donné un résultat positif en ce qui concerne la présence de l'eau oxygénée:
>
> Brassica asperifolia, B. oleifera, Daucus carota, Beta vulgaris, Geranium rotundifolium, Hedera helix, Laurocerasus, Aster, Tropœolum pentaphyllium, Chrysanthemum Balsamita, Mericurialis annua, Urtica, Calla palustris, Vicia fava, Papaver rhœas, Sisymbrium nastur-

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(1) Pringsheims Jahrb., vol. 17.

(2) Ber. Sächs. Akad. Wiss., 1889. p. 493.

(3) Comptes rendus., t. CXIX., p. 286.

(4) The solution contains in one liter 0.03 gr. potassium bichromate and 5 drops of aniline. In testing, one drop of a 5 % solution of oxalic acid is added for 5 cc. of the reagent.

tium, Dianthus Caryophyllus, Apium Petroselinum, Fragaria vesca.

Deux plantes ont donné un résultat douteux: Lactuca sativa, Vicia. Cinq plantes ont donné un résultat négatif: Medicago sativa, Cichorium Intybus, Avena sativa, Viola odorata, Lilium bulbiferum."

In regard to the mode of application he gives the following note:

"25 gr. de feuilles bien vertes et cueillies au milieu de la journée ont été placés dans une tasse de porcelaine spacieuse, arrosés par 75 cc. d'eau acidulée par 0.1 pour 100 d'acide oxalique.

Il faut éviter d'employer les acides mineraux, parce qu'ils décomposent certains glucosides et en mettent en liberté la tannin.

La tasse, couverte d'une soucoupe, a été gardée dans une chambre obscure. À des intervalles déterminés, des portions de 5 cc. ont été relevées sur l'extrait et essayées par le réactif, comme il a été indiqué plus haut.

Un essai à blanc a été opéré dans chaque cas avec 5 cc. de réactif, 5 cc. de l'eau acidulée et 1 ou plusieurs gouttes de la solution d'acide oxalique."

As it seemed to me of great interest to see whether the presence of hydrogen peroxide had thus been positively proved, I subjected the following twenty-one species of plants exactly to the same treatment as *Bach:*

Brassica oleracea.	Geranium nepalense.	Kerria japonica.+
Brassica chinensis.	Cornus officinalis.	Rubus trifidus.+
Pisum sativum.+	Corylopsis spicata.	Prunus Lauro-cerasus.
Vicia fava.	Urtica thunbergiana.	Styrax obassia.
Papaver rhœas.	Hydrangea hortensis.+	Chrysanthemum coronarium.+
Diervilla grandiflora.+	Daucus carota.+	Aster tartaricum.+
Lonicera morrowii.	Cryptotænia canadensis.	Beta vulgaris.+

In nine cases out of these twenty-one, I did, indeed, observe a reddish coloration, but it was not like that in the control test. I have marked these species in the list with+.

I found that in these cases parts of the leaves had died from the poisonous action of the oxalic acid, while in the other cases, where no reaction was obtained, all the leaves were still

uninjured, and the cuticula had prevented the entrance of the acid solution into the cells. In order to see whether the reaction obtained was, indeed, due to hydrogen peroxide, I added 0.5 gr. of platinum black to 20 cc. of the diluted oxalic acid solution that had been in contact with the leaves for twenty-four hours, and let the mixture stand with occasional stirring in a porcelain dish for one hour. A control experiment with a 0.1 % solution of hydrogen peroxide, having shown that by this means *hydrogen peroxide*(1) is so perfectly decomposed, that *Bach's* reaction shows not a trace of it, it was remarkable to find that in all the plants mentioned *the reddish coloration was obtained, and still of the same intensity as before treatment with platinum black.* The only conclusion to be drawn is that there was no hydrogen peroxide ever present, and it seems to me that *Bach* was not justified in declaring that it was so in any of the plants he examined, because he omitted to apply the platinum test to see whether the faculty of giving this reaction would be destroyed or not.

The coloration mentioned can very probably be obtained only in those cases where the leaves have been partially killed by the oxalic acid solution, and thus certain easily oxidisable organic matters made able to leave the cells by osmosis. These might by oxidation in presence of the aniline oxalate yield coloured products.

I doubt whether *Bach* ever observed his reaction in leaves that had remained *alive* in all parts.

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(1) The energetic decomposition of hydrogen peroxide by platinum black is an old and well known fact.

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Die Japanischen Laubhölzer im Winterzustande.

Bestimmungstabellen

VON

H. Shirasawa, *Ringakushi.*

VORWORT.

SCHWARZ hat in seinem "Forstliche Botanik" die Unterscheidungsmerkmale angegeben, wonach die forstlich wichtigen Pflanzen in Deutschland auch ohne Blüthen oder Früchte oder im ganz kahlen Zustand zu erkennen sind.

Eine Bearbeitung der japanischen Pflanzen in dieser Hinsicht liegt noch nicht vor, was als eine oft schwer gefühlte Lücke in unserem forstlichen Wissen zu betrachten ist, und mich darum veranlasst hat, die vorliegende Arbeit durchzuführen. Ich bin dabei hauptsächlich dem System von Schwarz gefolgt, so weit dies bei der naturgemäss grossen Verschiedenheit der deutschen und japanischen Flora möglich war.

Die zu dieser Arbeit verwendeten Examplare (von ungefähr 300 Arten, Baum- Strauch- und Schlinggewächsen) wurden meist in den botanischen Gärten in Komaba und Koishikawa, und dann in der Umgebung von Tokyo gesammelt. Da die im Garten gezogenen Pflanzen meist kein normales Wachsthum zeigen, so habe ich nebenbei auch frei im Walde erwachsene Pflanzen in Amagi, Nikko, und in der Provinz Shinano zur vergleichenden Betrachtung zugezogen.

Zu dieser Arbeit wurden zwei Winter benutzt. Bei dieser Kürze der Zeit konnten im Nachfolgenden noch nicht alle forstlich wichtigsten Pflanzen Japans bearbeitet werden. Indessen behalte ich mir vor, im nächsten Winter diejenigen Pflanzen, welche noch nicht berücksichtigt worden sind, näher zu untersuchen.

Ich kann hier nicht umhin den meinen wärmsten Dank Herren Dr. Grasmann, Prof. Matsumura, Assist. Prof. Shirai u.

Dr Honda, Prof. Dr. Kitao u. Prof. Dr. Ishikawa auszusprechen welche mir ihre gütige Hülfe bei der vorliegenden Arbeit hatten zu Theil werden lassen.

Tokyo Juni, 27 Meiji.

TABELLE I.

Die Knospen sind an den Langtrieben spiralig angeordenet.

I.—Die Knospen sind in der Blattnarbe verborgen.

Robinia Pseudacacia, *L.* Hari-enju. *Taf. I, Fig. 1.*

Die Blattnarbe ist ziemlich gross, höckerig, wird zumiest von zwei derben geraden Stacheln flankiert. Die Stacheln können auch fehlen. Zweige sparrig, hin- u. hergebogen, kantig, lang. Rinde braun od. grünlichbraun mit zahlreichen, feinen Lenticellen, im Alter braungrau bis grau. Mark unregelmässig eckig, ziemlich weit (nach Schwarz).

II.—Knospen gestielt.

a.—Eine grössere Schuppe umhüllt fast die ganze Knospe.

Alnus incana, Willd. var. glauca, *Ait.* Yama-hannoki. *Taf. I, Fig. 2.*

Knospen ziemlich gross eiförmig, schwach gekrümmt, undeutlich dreieckig, lang gestielt. Knospenschuppe dunkelcarminroth, bereift. Zweige hin- u. hergebogen, harzig. Die jüngeren Theile der Triebe sind feinfilzig behaart, grau, u. lassen die weissflichen Lenticellen nicht so deutlich erkennen. Mark dreieckig.

Alnus japonica, *Sieb. et Zucc.* Hannoki. *Taf. I, Fig. 3.*

Knospen schlank, lang, unregelmässig dreieckig, scharf kantig, etwas gefaltet. Die Spitze der Knospen schwach ge-

krümmt, harzig, glänzend. Jungtrieb dreikantig graubraun bereift, ältere grau. Lenticellen ziemlich erkennbar. Mark dreieckig.

Alnus firma, *Sieb. et Zucc.* Yashabushi. *Taf. I, Fig. 4.*

Knospen spindelförmig, gekrümmt, kurz gestielt, rothbraun glänzend, theilweise grünlichgelb. Blattnarbe abgerundetes Dreieck. Zweige hin- u. hergebogen, auf der Sonnenseite braun, auf der Schattenseite graubraun, die jüngeren Theile fein behaart. Lenticellen sehr deutlich. Mark unregelmässiges Dreieck.

Alnus viridis, DC. var. sibirica, *Regel.* Miyama-hannoki. *Taf. I, Fig. 5.*

Knospen ziemlich gross, spindelig, lang gestielt, zugespitzt u. gekrümmt. Knospenschuppen dunkelcarminroth, glänzend. Die jungen Zweige graubraun, kantig, mit elliptischen, deutlichen Lenticellen versehen, die älteren Zweige dunkelgrün, mit braunweisslichem Ueberzug. Blattenarbe halbkreis- od. herzförmig, u. von unregelmässiger Form.

b.—Mehrere Schuppen umgeben die Knospen spiralig.

Ribes fasciculatum, *Sieb. et Zucc.* Yabu-sanzashi. *Taf. I, Fig. 6.*

Knospen spindelförmig, lang, etwas gebogen, den Zweigen angedrückt, hellroth gefärbt. Jünge Triebe hellbraun, glänzend, bei Absterben der äusseren Peridermschichten grau, u. leicht sich abschifernd. Blattnarbe sichelförmig. Lenticellen undeutlich. Mark ziemlich weit.

III.—Knospen von unausgebildeten Blättchen gebildet, (nackt).

A.—Zweige auffallend dick.

a.—Mark gefächert.

Juglans Sieboldiana, *Max.* Oni-gurumi. *Taf. I, Fig. 7.*

Endknospe viel grösser als Seitenknospe, pyramidal, etwas gebogen, graubraun filzig behaart. Junge Zweige braun behaart, ältere weisslichgrau, kahl. Blattnarbe sehr gross breit

herzförmig. Mark weit fünfeckig, gefächert. Bei Verwundung der Basttheile zeigt sich gelbe Färbung.

Juglans cordiformis, *Max.* Hime-gurumi. *Taf. I, Fig. 8.*

Knospen u. Zweige ganz ähnlich wie bei der vorhergehenden Art, daher die Unterscheidung im Winterzustande schwer.

Pterocarya rhoifolia, *Sieb. et Zucc.* Sawa-gurumi.
Taf. I, Fig. 10.

Knospen dreikantig, lang, auf dem Längschnitte spatelförmig, an der Spitze etwas gedreht, graubraun filzig behaart. Zweige gerade, ganz kahl, die jüngeren Theile hellbraun od. grau. Mark ziemlich weit, eckig, gefächert.

Juglans regia. L. var, sinensis, *Cas.* Teuchi-gurumi.
Taf. I, Fig. 9.

Endknospen grösser als Seitenknospen, glockenförmig, etwas kantig, dunkelgrau filzig behaart; die äusseren 2 od. 4 eigentlichen Schuppen leicht ablösbar. Seitenknospen kugelig. Zweige dick, die jüngeren graulich braun od. grün; die älteren grau glänzend. Wenige Lenticellen, an jüngeren Zweigen deutlicher als an älteren. Blattnarbe gross, breitherzförmig. Mark gross etwas gefärbt.

β.—Mark nicht gefächert.

Cedrela chinensis, *Juss.* Chanchin. *Taf. II, Fig. 10.*

Endknospe sehr viel grösser als Seitenknospen, von mehreren unausgebildeten Blättchen locker umhüllt, dunkelbraunfilzig behaart. Seitenknospen kugelig. Zweige dick, dunkelgelbbraun, glänzend, schwarz bestäubt. Blattnarbe gross, rundlich, grauweiss, mit meist 5 Gefässbundelspuren versehen. Lenticellen wenig, deutlich. Mark weit, rundlich.

Rhus vernicifera, *DC.* Urushi. *Taf. I, Fig. 12.*

Endknospen viel grösser als Seitenknospe, pyramidal, an der Spitze etwas gekrümmt. Zwei od. drei grosse unausgebildete Blättchen umgeben fast die ganze graufilzig behaarte Knospe, Seitenknospen kugelig. Zweige dick, grau, glänzend, mit mehreren Lent. versehen. Blattnarbe breit herzförmig .

Mark weit. Beim Abschneiden der Rinde fliesst gummiartige Flüssichkeit aus, giftig.

Rhus trichocarpa, *Miq.* Yama-urushi. *Taf. I, Fig. 14.*

Endknospe grösser als Seitenknospe, pyramidal, braunfilzig behaart. Seitenknospen etwas flach. Zweige weniger dick als die Rhus virnicifera, mit vielen, feinen Lenticellen, dunkelgrau gefärbt. Blattnarbe gross, ein gleichschenkliges Dreieck bildend, glänzend, röthlich gefärbt. Mark weit.

Rhus succedanea, *L.* Haze. *Taf. I, Fig. 11.*

Endknospen sehr gross, pyramidenförmig, von unausgebildeten Blättchen auf drei Seiten dicht umhüllt; sie sind hellbraufilzig behaart. Seitenknospen klein, keilförmig. Zweige graubraun. Blattnarbe halbmondförmig. Mark weit, etwas eckig.

Rhus sylvestris, *Sieb. et Zucc.* Yama-haze. *Taf. I, Fig. 13.*

Knospen ähnlich wie bei der vorhergehenden Art, aber locker umhüllt, von unregelmässiger Form, gelblichbraun filzig behaart. Seitenknospen flach, u. lang. Zweige dunkelgrau, schmutzig gefärbt. Blattnarbe wie bei Rhus vernicifera. Mark weit.

B.—Zweige weniger dick.

a.—Zweige ohne Stacheln od. Dornen.

Halesia hispida, *Benth. et Hook.* Ke-asagara. *Taf. I, Fig. 16.*

Knospen spindelig, gelblichgrau od. gelb gefärbt. Endknospen grösser als Seitenknospen, etwas gebogen, lang. Blattnarbe gross schildförmig. Seitenknospen parallel stehend an den Trieben. Junge Zweige hellgelbbraun, ältere braun. Lenticellen deutlich. Mark ziemlich weit, eckig. Die Rinde hat eigentümlichen Geruch.

Halesia corymbosa, *Benth. et Hook.* Asagara. *Taf. I, Fig. 17.*

Zwei unausgebildete Blättchen umgeben die eiförmige, dunkelbraune, kleinwalzige Knospe. Zweige hin u. hergebogen, braun, kleinwalzig, ältere dunkelgraubraun. Blattnarbe gross vier eckig. Lent. undeutlich. Mark rund.

Ramnus crenata, *Sieb. et Zucc.* Isonoki. *Taf. I, Fig. 19.*

Endknospen grösser als Seitenknospen, pyramidenförmig, an der Spitze gekrümmt, od. abgeflacht, graubraunfilzig behaart. Zweige schlank, jüngere Theile behaart, dunkelbraun. Lenticellen deutlich. Mark rund.

Meliosma myriantha, *Sieb. et Zucc.* Awabuki. *Taf. I, Fig. 20.*

4 od. 5 pfriemenförmige, unausgebildete Blättchen an der Spitze der Triebe zusammensitzend, braunfilzig behaart. Blattnarbe halbelliptisch, u. die Gefässbündelspuren U-förmig angeordnet. Zweige dunkelrothbraun, auf der Schattenseite grau. Lent. deutlich. Mark elliptisch.

Mallotus japonica, *Muell. Arg.* Akame-gashiwa. *Taf. I, Fig. 18.*

Knospen von 4 od. 6 unausgebildeten, gelblichbraunen, weisslich bereiften Blättchen umhüllt, wovon zwei gegenständig sind meist grösser als die anderen. Endknospen wesentlich grösser als Seitenknospen, die letzteren parallel stehend an der Triebe meist mit Nebenknospen. Zweige dick, dunkelbraun, die jüngeren Theile bereift, kantig. Lenticellen undeutlich. Mark sehr weit.

b.—Zweige mit Stacheln od. Dornen.

α.—Zweige mit Stacheln.

Caesalpinia sepiaria, *Roxb.* Jaketsu-ibara. *Taf. II, Fig. 3, 4.*

Knospen sind von zwei unausgebildeten Blättchen umgeben, u. über den Blattachseln etwas entfernt stehend. Zweige ziemlich dick, mit zahlreichen, derben zurückgebogenen Stacheln auf der ganzen Fläche der Triebe, gelblichbraun od, braun gefärbt. Blattnarbe gross. Lent. deutlich. Mark weit. etwas gefärbt.

β.—Zweige mit Dornen.

Elaeagnus umbellata, *Thunb.* Aki-gumi. *Taf. II, Fig. 2.*

Endknospen etwas grösser als Seitenknospen, pyramidenförmig. Seitenknospen etwas flach, an den Trieben senkrecht stehend. Zweige u. Knospen mit kleinen, zusammengedrückten grauweissen Schuppen bedeckt. Zweige schlank. Blattnarbe halbmondförmig. Lent. undeutlich. Mark weit, rund.

Elaeagnus longipes, *A. Gray.* Natsu-gumi. *Taf. II, Fig. 1.*

Endknospen dreikantig, nicht zugespitzt. Seitenknospen etwas flach. Zweige u. Knospen sind mit kleinen zusammengedrückten, braunen, od. dunkelbraunen Schuppen bedeckt, an der ersteren sind stärkere Dornen vorhanden. Blattpolster hoch vorspringend; Blattnarbe rundlich, od. halbmondförmig. Mark sehr weit, rundlich.

IV.—Knospen sitzend, so klein, dass man die Stellung u. Zahl der Schuppen nicht mehr deutlich wahrnehmen kann.

α.—Zweige mit metamorphosierten Nebenzweigen.

Lycium chinense, *Mill.* Kuko.

Knospen kugelig. Schuppen braun. Zweige dünn, grau, bei zunehmender Dicke mit 5 zeiligen Korkleisten versehen. Mark weit. Rinde hat eigentümlichen unangenehmen Geruch.

β.—Zweige mit Dornen.

Zizyphus vulgaris, *Lam.* Natsume. *Taf. II, Fig. 5.*

Knospen ziemlich gross, meist unter der halbmondfömigen Blattnarbe sitzend. Junge Zweige lang gestreckt, dunkelgelblich braun, ältere Zweige schwärzlich grau mit grossen Kurztrieben. Zweige und Kurztriebe deutlich von einander verschieden. Stacheln schlank, je zwei neben jeder Knospe. Lent. fein, wenig deutlich. Mark von unregelmässiger Form. Holz gelblich.

Paliurus aubletia, *Roem et Sch.* Hama-natsume. *Taf. II, Fig, 6.*

Knospen klein, gelblich braun, behaart. Zweige hin- u. hergebogen, gelblich- od. gräulichgrün, bereift. Stacheln lang u. derb, glänzend dunkelbraun, je zwei neben den Knospen stehend. Lenticellen deutlich. Mark rundlich.

γ.—Zweige ohne metamorphosierten Nebenzweigen oder Dornen.

Ilex Sieboldii, *Miq.* Umemodoki. *Taf. II, Fig. 8.*

Knospen kegelig, etwas zugespitzt. Endknospe grösser als Seitenknospen, jede mit einer Nebenknospe auf der unteren

Seite. Knospenschuppen schwach behaart. *Z*weige hin- u. hergebogen, dunkelgrau. Blattnarbe halbmondförmig. Lenticellen *z*ahlreich, deutlich. Mark schmal, unregelmässiger Form.

Ilex geniculata, *Max.* Fūrin-umemodoki. *Taf. II, Fig. 7.*

Knospen wie bei der vorhergehenden Art. *Z*weige dunkelcarminbraun, glänzend, gerade. Blattnarbe halbkreisförmig. Die jüngeren *Z*weige unterscheiden sich von den älteren durch ganz verschiedene Färbung. Mark zeimlich weit, von unregelmässiger Form.

Hibiscus syriacus, *L.* Mukuge.

Knospen grau behaart. *Z*weige grau, od. dunkelgraubraun, mit feinen Lenticellen, bereift. Blattpolster etwas vorspringend. Blattnarbe rundlich od. halbmondförmig. Mark rund.

V.—Knospen sitzend, Zahl der Schuppen od. kleinen zusammengedrückten Blättchen undeutlich.

A.—Einjährige *Z*weige auffallend dick.

a.—*Z*weige ohne Stacheln od. Dornen.

α.—Knospen filzig behaart.

Ailanthus glandulosa, *Desf.* Shinju.

Knospen gleichgross, verhältnissmässig klein, halbkugelig, roth, weisslich behaart. Blattnarbe sehr gross. *Z*weige unregelmässig gebogen. Die einjährige Triebe sehr fein od. dicht behaart, hellbraun, die ältere grau bis braun. Mark sehr weit, rund.

Melia japonica, *G. Don.* Sendan. *Taf. II, Fig. 9.*

Knospen kugelig, hellbraun dicht behaart. Einjährige *Z*weige dick, dunkelgrün, mit vielen deutlichen Lenticellen, bereift. Blattnarbe etwas vorspringend. Mark weit, rundlich. Hol*z* gelb gefärbt.

Rhus semi-alata, *Murr.* **var. Osbeckii.** *DC.* Nurude.
Taf. II, Fig. 12.

End- u. Seitenknospen gleich gross, mit weissbrauner, baumwolle-artiger, dichter Behaarung. *Z*weige hellgraubraun, schwach glänzend, gerade, schwärzlich gefleckt. Blattnarbe

gröss, umfasst fast die ganze Knospe, von nebenstehender Form, . Lenticellen deutlich. Mark sehr weit, etwas gefärbt.

β.—Knospen nicht od. wenig behaart.

Ehretia acuminata, *R. Br.* Chishanoki. *Taf. II, Fig. 13.*

Knospen auf dem Zweige ganz dicht sitzend, von kurzer stumpfer Kegelform. Zwei graue, od. dunkelbraune wenig behaarte Schuppen umhüllen die Knospe von beiden Seiten. Zweige ziemlich dick, grau, glänzend, schwach behaart, fühlen sich rauh an. Lenticellen wenig, deutlich. Blattnarbe rundlich, od. halbelliptisch. Mark sehr weit, rundlich.

Sapindus Mukurosi, *Gaertn.* Mukuroji. *Taf. II, Fig. 11.*

Knospen dicht sitzend, halbkugelig, 4 Schuppen umgeben ganz dicht die Knospe. Blattnarbe gross herzförmig. Zweige dick, graugrün, schmuzig bestäubt. Lenticellen zahlreich, deutlich. Mark weit, gefärbt. Rinde gelblich.

b.—Zweige mit Stacheln oder Dornen.

Zanthoxylum ailanthoides, *Sieb. et Zucc.* Karasuno-sanshō. *Taf. III, Fig. 3.*

Knospen beulenförmig, ganz dicht an der Triebe sitzend, so dass man die Zahl der Schuppen nicht deutlich wahrnehmen kann. Zweige affallend dick, dunkelgraubraun mit zahlreichen Stacheln. Blattnarbe gross, rundlich. Mark weit, gefächert. Die Rinde hat einen eigenthümlichen Geruch.

B.—Einjährige Zweige weniger dick.

a.—Zweige ohne Stacheln od. Dornen.

α.—Knospen nicht od. wenig behaart.

Albizzia Julibrissin, *Boiv.* Nemu. *Taf. II, Fig. 16.*

Knospen klein kegelförmig, etwas flach, über der dreieckigen Blattnarbe sitzend. Zweige hin- u. hergebogen; die jüngeren graubraun schwarz bestäubt, schmutzig. Lenticellen deutlich. Mark weit, strahlenförmig.

β.—Knospen behaart.

Sophora japonica, *L.* Enju. *Taf. II, Fig. 17.*

Knospe klein, von dem Blattpolster umfasst, u. im inneren Theile derselben sitzend. Schuppen undeutlich, mit dunkelcarminvioletter Behaarung. Einjährige Zweige grün, auf der Sonnenseite gelb od. bräunlichgrün, die älteren Zweige grau. Die äusseren Peridermschichten reissen in Längsstreifen auf. Mark rundlich. Die Rinde hat einen eigenthümlichen Geruch.

Marlea platanifolia, *Sieb. et Zucc.* Urinoki. *Taf. II, Fig. 20.*

Knospen entwickeln sich aus der Mitte der Blattnarbe, graubraunfilzig dicht behaart, kugelig mit kleinen Nebenknospen auf der unteren Seite. Zweige braun, gerade, hin- u. hergebogen. Lenticellen zahlreich. Mark weit, etwas gefärbt. Rinde mit Geruch.

Styrax Obassia, *Sieb. et Zucc.* Hakuun-boku. *Taf. II, Fig. 22.*

Knospen entwickeln sich aus der Mitte der Blattnarbe, eiförmig, lang, etwas flach, mit kleinen Nebenknospen, gelbbraunfilzig behaart. Zweige gerade, hin- u. hergebogen, die jüngeren rothbraun glänzend, glatt, die älteren dunkelbraun. Blattnarbe elliptisch. Lenticellen undeutlich. Mark rund.

Styrax japonica, *Sieb. et Zucc.* Egonoki. *Taf. II, Fig. 21.*

Knospen weniger gross, eiförmig etwas kantig, an der Spitze gekrümmt, dichtfilzig behaart. Zweige dünn besenförmig, die jüngeren hellbraun glänzend, bei der älteren die äusseren Peridermschichten in Längenstreifen aufreissend, so dass dieselben mit faserigen Peridermschichten bekleidet erscheinen. Lenticellen undeutlich. Mark klein, rund.

b.—Zweige mit Stacheln od. Dornen.

a.—Zweige mit Dornen.

Cudrania triloba, *Hance.* Hari-guwa. *Taf. II, Fig. 18, 19.*

Knospen dicht sitzend an der Triebe, beulenförmig, Schuppen undeutlich, dunkelgrünbraun gefärbt. Die einjährigen Zweige grün od. graugrün mit senkrecht stehenden starken Dornen. Blattnarbe halbmondförmig. Lenticellen ganz deutlich. Mark rund.

Gleditschia japonica, *Miq.* Saikachi. *Taf. II, Fig. 14, 15.*

Die Hälfte der Knospen von der Rinde umgefasst, so dass man die Knospenschuppen nicht ganz deutlich wahrnehmen kann. Zweige grün, glänzend, ziemlich dick, mit starken, verzweigten Dornen. Die einjährigen Zweige mit leicht abschilfbaren, feinen Peridermschichten. Blattnarbe von der Form, . Lenticellen sehr deutlich, rund. Mark eng.

β.—Zweige mit Stacheln.

Zanthoxylum piperitum, *DC.* Sanshō. *Taf. II, Fig. 23.*

Knospen von zusammengedrückten Blättchen bekleidet; die Seitenknospen kugelig. Die Zahl der Blättchen undeutlich, braun. Zweige schwarzbraun. Auf jeder Seite der Knospe zwei Stacheln. Blattnarbe halbmondförmig. Lenticellen deutlich. Mark rund. Die Rinde hat einen eigenthümlichen Geruch, u. scharfen Geschmack.

Zanthoxylum alatum, *Roxb.* Fuyu-zanshō. *Taf. III, Fig. 2.*

Endknospe lang gestreckt, Seitenknospen kugelig, Schuppenblättchen wenig deutlich, dunkelgrün gefärbt. Stacheln sind sehr breit u. lang, rothbraun glänzend. Zweige wie Stacheln gefärbt. Blattnarbe ziemlich gross, halbmondförmig od. halbelliptisch. Mark weit, rund. Die Rinde hat einen eigenthümlichen Geruch, aber weniger scharf als Zan. piperitum. Im Winter verbleiben einige grüne Blätter.

Zanthoxylum schinnifolium, *Sieb. et Zucc.* Inu-zanshō. *Taf. III, Fig. 1.*

Seitenknospen gegen Triebe zu abgeplattet. Knospenschuppen undeutlich. Zweige dunkelbraun, schwarz bestäubt. Nur einzelne Stacheln längs des Triebes vorhanden. Blattnarbe halbelliptisch. Lenticellen deutlich. Mark weit, rund.

VI.—Knospen sitzend mit einer bezw. zwei Schuppen.

A.—Knospen ausgesprochen kegelförmig, von der Blattnarbe ringförmig umgeben.

a.—Knospen od. junge Zweige behaart.

Salix brachystachys, *Benth.* Ōsaruko-yanagi. *Taf. III, Fig. 5.*

Blütenknospen gross spindelförmig; Laubknospen kleiner,

kegelig, gegen die Triebe zu geplattet. Nur eine röthlich gefärbte, u. weiss od. grau behaarte Schuppe umhüllt die ganze Knospe. Zweige röthlich, dunkelgrau behaart. Lenticellen wenig. Mark weit, eckig.

b.—Knospen od. Zweige nicht behaart.

Salix gracilistyla, *Miq.* Kuro-yanagi. *Taf. III, Fig. 6.*

Knospen kegelförmig, gegen die Zweige zu abgeplattet. Blütenknospen spindelig, lang, an der Spitze etwas gebogen. Zweige u. Knospenschuppen dunkelröthlich, glänzend. Man kann diese von anderen Arten leicht unterscheiden, durch die röthlichen, auf der Lichtseite aber schwärzlichen Blütenkätzchen.

Salix japonica, *Thunb.* Shiba-yanagi. *Taf. III, Fig. 8, 9.*

Knospen kegelförmig, lang, an der dem Treibe zugewendeten Seite abgeplattet. Blütenknospen grösser als Blattknospen, an der Spitze gekrümmt. Einjährige Zweige u. Knospenschuppen, auf der Lichseite röthlich gefärbt, glänzend, ältere Zweige graubraun, hin- u. hergebogen. Blattpolster vorspringend. Lenticellen wenig, deutlich. Strauchartig, nicht aufrecht stehend.

Ficus carica, *L.* Ichijiku. *Taf. III, Fig. 4.*

Endknospe kegelig, an der Spitze etwas gebogen. Eine grosse, grünlichgelbe Schuppe umhüllt fast die ganze Knospe. Seitenknospen halbkugelig, zugespitzt, von mehreren Schuppen umgeben, schwarzlichbraun. Zweige dick, hin- u. hergebogen, dunkelbraun. Blattnarbe rundlich, Mark etwas eckig (sechseckig). Die verholzten Triebe von unreglmässiger Form. Bei Verwundung der Basttheile fliesst milchartiger Saft aus.

B.—Knospen nicht kegelförmig, stehen über der Blattnarbe. Nur eine beiderseits kantige Schuppe (aus zwei Schuppen verwachsen).

a.—Zweige dottergelb.

Salix purpurea, *L.* Kawa-yanagi. *Taf. III, Fig. 11.*

Knospen sind an der Spitze der Zweige kleiner als in der Mitte derselben. Die letzteren sind circa 2–3 mal so lang

als breit, die röthlichbraun behaarten Knospen stehen an dem Zweige sehr dicht. Blattpolster etwas vorspringend. Seitenzweige sehr dünn, gelblich bis grünlichgrau, behaart.

Salix sp. (?)

Knospen halbkugelig od. etwas lang gestreckt. Blütenknospen wesentlich grösser, eiförmig, an der Spitze gekrümmt, gekielt. Zweige u. Knospenschuppen dottergelb, glänzend. Blattpolster vorspringend. Blattnarbe von der Form . Mark ziemlich weit, etwas eckig.

b.—Einjährige Zweige roth od. braun, glänzend wie lackiert.

a.—Knospen dichtfilzig behaart.

Hovenia dulcis, *Thunb.* Kenponashi. *Taf. III, Fig. 18, 19.*

Zwei Knospen aufeinander sitzend, die untere Nebenknospe kleiner als die obere, die letztere kegelförmig, etwas kantig, schwärlich braun behaart. Die einjährigen Zweige stark hin- u. hergebogen, auf der Lichtseite dunkelbraun. Lenticellen ziemlich deutlich. Mark eng, rund.

Magnolia Kobus, *DC.* Kobushi. *Taf. III, Fig. 15.*

Knospen eiförmig, lang gestreckt, an der Spitze etwas gekrümmt (Endknospen grösser als Seitenknospen.) dunkelgrau, schwarz behaart. Zweige dunkelrothbraun, auf der Schattenseite gelblich grün. Blattnarbe sichelförmig, schmal. Lenticellen deutlich. Mark gross u. rund. Die Rinde hat eigenthümlichen, angenehmen Geruch.

Magnolia obovata, *Thunb.* Mokuren. *Taf. III, Fig. 14.*

Knospen eiförmig ziemlich lang, beiderseits abgeplattet, etwas kantig u. gekrümmt. Knospenschuppen grauweissfilzig behaart. Blütenknospen bedeutend grösser als Laubknospen, an der Spitze der Triebe sitzend. Blattnarbe von der Form eines abgerundeten Dreiecks. Zweige schwärzlich braun. Mark gross, rund. Lenticellen deutlich. Die Rinde hat eigenthümlichen Geruch, jedoch schwächer als die vorige Art.

β.—Knospen nicht behaart.

Andromeda ovalifolia, *Wall.* Kashioshimi. *Taf. III, Fig. 16, 17.*

Knospen eiförmig, etwas flach. Schuppen roth, glänzend. Einjährige Zweige roth gefärbt, glänzend wie lackiert; ältere dunkelgrau. Blattnarbe halbmondförmig, in der Mitte mit einer einzigen Gefässbündelspur. Lenticellen undeutlich. Mark elliptisch.

Stachyurus praecox, *Sieb. et Zucc.* Kifuji. *Taf. III, Fig. 21.*

Endknospen kugelig zugespitzt. Seitenknospen eiförmig, gespitzt, an der Triebe angedrückt. Schuppen dunkelrothbraun. Zweige von derselben Farbe, glänzend. Lenticellen sehr deutlich. Mark rund, u. sehr weit.

Salix Thunbergiana, Neko-yanagi. *Taf. III, Fig. 12.*

Knospen halbkugelig. Nur eine, dunkelrothglänzende Schuppe umgibt fast drei ganze Knospe. Blütenknospen eiförmig, gross, gekielt. Zweige auf der Lichtseite dunkelroth, auf der Schattenseite gelbgrün. Blattpolster vorspringend. Blattnarbe schmal, umfasst die Hälfte der Knospe. Lenticellen sehr wenig. Mark ziemlich weit.

Itea japonica, *Oliv.* Zuina. *Taf. III, Fig. 20.*

Hat eigentlich drei Schuppen, wird daher in VII, *A*, b. beschreiben.

Helwingia ruscifolia, *Willd.* Hanaikada. *Taf. V, Fig. 7, 8.*

Endknospen pyramidenförmig, grösser als Seitenknospen. Die letzteren flach, keilförmig. Schuppen röthlich grün, kahl. Zweige haben dieselbe Färbung od. gelblichgrün, glänzend. Blattnarbe fast halbkreisförmig. Lenticellen deutlich, vereinzelt. Mark weit, rund.

c.—Zweige nicht auffällig gefärbt, Knospen lang gestreckt.

α.—Knospen nicht behaart, walzig.

Magnolia hypoleuca, *Sieb. et Zucc.* Hōnoki. *Taf. III, Fig. 22.*

Knospen sehr gross, spindelig, von gleichem Durchmesser wie die Triebe, 4 cm. od. darüber lang. Die zwei Knospenschuppen sind verwachsen, u. zeigen an der Verwachsungsstelle eine Naht. Zweige dick, lang gestreckt, aufrecht stehend,

ohne Nebenzweige. Die einjährigen Zweige grünbraun. Lent. deutlich, lang. Mark rund. Die Rinde hat einen eigenthümlichen, angenehmen Geruch.

β.—Knospen sehr wenig od. gar nicht behaart, zugespitzt.

Lindera hypoleuca, *Max.* Kuromoji. *Taf. VI, Fig. 4, 5.*

Knospen spindelig, lang; Schuppen röthlichgelb wenig behaart. Zweige glatt, auf der Lichtseite röthlich, auf der Schattenseite gelbgrün, die älteren schwärzlich. Blattnarbe von der Form, . Lenticellen sehr wenig. Mark rund. Die Rinde hat einen eigenthümlichen, angenehmen Geruch.

γ.—Knospen behaart, dem Stengel angedrückt.

Salix viminalis, *L.* Kinu-yanagi. *Taf. III, Fig. 13.*

Knospen sehr verschieden gross, dem Zweige dicht angedrückt, die Spitze etwas gebogen, (besonders bei den grossen Knospen). Die jüngsten Zweigteile dichtfilzig behaart, ältere röthlichgelb, glänzend. Zweige oft von grosser Länge.

d.—Zweige grün od. braun; Knospen (vergekehrt) keilförmig.

a.—Blattnarbe rundlich.

Diospyros Kaki, *L. fil.* Kaki. *Taf. III, Fig. 23.*

Knospen keilförmig; Schuppen (oft zwei od. mehr) hellbraun, schwach behaart. Zweige ziemlich dick, hellbraun; die jüngeren schwach behaart. Blattnarbe gross, rundlich, gewölbt. Lent. deutlich. Mark von unregelmässiger Form.

Diospyros Lotus, *L.* Mame-gaki. *Taf. III, Fig. 24.*

Knospen keilförmig, lang; die Spitze etwas gebogen. Schuppen grünbraun, schwärzlich gefleckt, wenig behaart. Zweige grünbraun etwas glänzend, schmutzig.

Broussonetia Kasinoki. *Sieb.* Kōzo. *Taf. IV, Fig. 2.*

Knospen keilförmig, kurz, aufrecht stehend obenhalb der Blattpolster, Knospenschuppen dunkel od. schwarzbraun, schwach behaart. Junge Zweige dunkelbraun od. schwarzbraun, schmutzig. Lent. vorspringend, sehr deutlich. Mark rund, weit.

Broussonetia Kasinoki, *Sieb. var.* Hime-kōzo. *Taf. IV, Fig. 1.*

Knospen wie bei der vorgenannten Art, verhältnissmässig gross, an die Triebe angedrückt. Schuppen dunkelbraun. Blattpolster vorspringend; Blattnarbe rund. Zweige schlank, hin- u. hergebogen, dunkelbraun od. schwärzlichbraun. Lenticellen sehr deutlich. Mark rund.

Broussontia papyrifera, *Vent.* Kajinoki. *Taf. IV, Fig. 3.*

Endknospen grösser als Seitenknospen, die ersteren locker beschuppt, die letzteren dicht, von etwas kegeliger Form. Zweige ziemlich dick, dunkelgraulich grün. Die jüngeren Theile mit weissglänzenden, langen Haaren bedeckt. Blattnarbe gross, rundlich. Lenticellen deutlich. Mark weit.

β.—Blattnarbe nicht rundlich.

*.—Zweige dünn.

Stillingia sebifera, *Boxb.* Nankin-haze.

Knospen klein, keilförmig, an der Langtriebe sehr zahlreich sitzend. Schuppen duukel od. schwarzbraun. Beiderseits der Knospe je eine Nebenknospen sitzend. Jünge Zweige, grün, schlank, lang gestreckt; ältere grünbraun. Blattnarbe halbmondförmig. Lenticellen deutlich. Mark eng, rund.

Lagerstroemia indica, *L.* Sarusuberi. *Taf. IV, Fig. 5.*

Knospen keilförmig, zugespitzt; Schuppen dunkelbraun. Zweige dünn, braun gefärbt. Die äusseren Paridermschichten reissen in Längsstreifen auf, und blättern sich in langen unregelmässigen Bändern ab. Blattnarbe von Linsenform. Lenticellen undeutlich. Mark rund. Die Knospen sind an den Langtrieben zumeist gegenständig angeordnet.

Spiraea betulifolia, *Pall.* Maruba-shimotsuke. *Taf. IV, Fig. 6.*

Knospen flach, die Spitze pfriemenförmig, lang gestreckt, u. gekrümmt, dunkelbraun. Zweige schlank, besenförmig, dunkelbraun. Blattpolster vorspringend. Blattnarbe sehr klein. Mark weit, etwas eckig.

**.—*Zweige ziemlich dick.*

Cladrastis amurensis, *Benth. et Hook.* **var. floribunda,** *Max.*
Inu-enju. *Taf. IV, Fig. 7.*

Knospen dicht sitzend über der Blattnarbe, keilförmig, am Rücken derselben etwas nach vorne gewölbt; die Spitze schwach gekrümmt. Schuppen schwarzbraun, wenig behaart. Zweige dick, schwarz od. dunkelbraun. Blattnarbe sichelförmig. Mark weit, von unregelmässiger Form. Die Rinde hat einen eigenthümlichen unangenehmen Geruch. Das Holz nimmt hellgelbe Färbung an.

Cercis chinensis, *Bunge.* Hanazuō. *Taf. IV, Fig. 9, 10.*

Knospen klein, flach, keilförmig, an der dem Triebe zugewendten Seite abgeplattet, rückseits derselben eine kleine Nebenknospe. Die Schuppen schwarzbraun. Blattnarbe vorspringend, umfasst die Nebenknospe. Blüthenknospen kieferzapfenförmig. Zweige hellbraun, hin- u. hergebogen, mit feinen Lenticellen versehen. Mark eng, rundlich.

Excoecaria japonica, *J. Muell.* Shiraki. *Taf. IV, Fig. 8.*

Knospen keilförmig, zugespitzt. Knospenschuppen braun, unterseits derselben Carminviolett gefleckt. Zweige graubraun, hin- u. hergebogen. Blattnarbe halbmondförmig. Lent. deutlich. Mark weit, rundlich. Die Rinde hat einen eigenthümlichen Geruch.

Koelreuteria paniculata, *Laxm.* Mokugenju. *Taf. IV, Fig. 4.*

Knospen ziemlich dick, von kugeliger Form. Schuppen glänzend graubraun, behaart. Zweige dicker als vorgenannte Arten, in der Längsrichtung 2–4 tiefe Furchen laufend, graubraun schwärzlich bestäubt, schmutzig. Blattnarbe herzförmig. Mark sehr weit, von unregelmässiger Form.

VII.—Knospen sitzend, von mehreren Schuppen umgeben. Zweige auffallend schlank, od. besenförmig.

A.—*Zweige rothbraun, glänzend.*

a.—Strauchartig.

Prunus japonica, *Thunb.* Niwa-ume. *Taf. VI, Fig. 8.*

Knospen klein, etwas kantig, röthlich, meist zwei derselben

nebeneinander sitzend. *Z*weige schlank, gerade, besenförmig, dunkelrötlich od. rothbraun, schmutzig bestäubt. Blattpolster ziemlich hoch.

Itea japonica, *Oliv.* Zuina. *Taf. III, Fig. 20.*

Knospen halbkugelig, von drei Schuppen (zu beiden Seiten u. Rückwärts) umgeben. *Z*weige gelblichrothbraun. Blattpolster vorspringend. Lenticellen deutlich. Mark etwas eckig.

Spiraea cantoniensis, *Lour.* Kodemari. *Taf. IV, Fig. 19.*

Knospen spindelförmig, kurz, schwach eckig, hellbraun. *Z*weige dunkelrothbraun, glänzend. Die äusseren Korkschichten leicht abschälbar. Lenticellen undeutlich. Mark weit, eckig.

b.—Baumartig.

Betula alba, *L.* **subsp. verrucosa var. vulgaris,** *Regel.* Shirakaba. *Taf. IV, Fig. 12.*

Knospen spindelig, lang. Schuppen dunkelgelbbraun, harzig. Einjährige *Z*weige gelbbraun, hin- u. hergebogen, kleinwalzig mit einem weissen Ueberzug, sehr rauh anzufühlen; die älteren dunkelgelbbraun. Lent. deutlich. Mark sehr eng. von unregelmässiger Form, dreieckig od. viereckig.

Betula Bhojpattra, *Wall.* **var. typica.** *Regel.* Onoore. *Taf. IV, Fig. 13, 14.*

Knospen eiförmig, lang, locker beschuppt, behaart, hellbraun teilweise dunkel gefärbt. *Z*weige schlank, kleinwalzig, mit weisslichem Ueberzug, die jüngeren hellbraun, ältere dunkelbraun Blattnarbe schmal. Lent. deutlich. Mark eng. Das Holz dieser Art ist das härteste unter allen Betulaarten; ältere Stämme mit rauher Borke.

Betula alba, *L.* **subsp. papyrifera var. communis,** *Regel.* Makamba. *Taf. IV, Fig. 15.*

Knospen u. *Z*weige ähnlich wie bei der B. vulgaris, u. von dieser unterschieden, durch weissbraune Rinde, während B. vulgaris silberweisse Rinde besitzt.

Betula globispica, *Shirai.* Jizōkamba. *Taf. IV, Fig. 16.*

Knospen eiförmig, zugespitzt. Knospenschuppen dunkelbraun od. hellbraun. *Z*weige schlank, graubraun. Blatt-

narbe halbmondförmig. Lenticellen deutlich, linsenförmig. Mark schmal von unregelmässiger Form.

Betula alba, subsp. latifolia, var. Tauschii, ? *Taf. IV, Fig. 11.*

Blattnarbe kurze, stumpfe Dreiecke. Lent. deutlich. Mark eng, von unregelmässiger Form.

Amelanchier asiatica, *Koch.* Zaifuri-boku. *Taf. IV, Fig. 17.*

Die ganze Form der Knospe eiförmig, lang, sehr locker beschuppt. Die äussere Hälfte der Schuppen u. die inneren Schuppen pfriemenförmig, hellroth gefärbt, am Rande derselben baumwolleartig lang behaart. Zweige schlank, roth od. rothbraun glänzend. Die älteren Zweige dunkelgrau mit mehreren gebrümmten Kurztrieben. Blattnarbe klein. Lent. deutlich. Mark rund, weit.

B.—Zweige grau, dunkelgrau od. graubraun.

Pourthiana villosa, *Decne.* Ushikoroshi. *Taf. IV, Fig. 18.*

Knospen kegelig, ziemlich kurz, flach, 3–4 Schuppen erkennbar, rothbraun, weiss gefleckt. Blattpolster vorspringend; Blattnarbe schmal. Zweige braunlich grau, schlank. Lent. deutlich.

Stephanandra flexuosa, *Sieb. et Zucc.* Kogome-utsugi.
Taf. IV, Fig. 20.

Knospen spindelig, kurz, röthlich gefärbt. Zweige schlank, lang gestreckt, hin- u. hergebogen, graubraun, etwas glänzend. Die Zweige an der Haupttriebe fast senkrecht stehend. Lent. undeutlich. Mark weit, etwas gefärbt.

Spiraea japonica, *L. fil.* Shimotsuke. *Taf. IV, Fig. 21.*

Knospen kegelförmig, kurz, von mehreren pfriemförmigen Schuppen umgeben, hellbraun. Zweige graubraun od. braun, kleinwalzig. Lent. undeutlich. Mark sehr weit.

Spiraea prunifolia, *Sieb. et Zucc.* Shijimibana.

Knospen spindelig, kurz. Zweige graubraun, schlank, besenförmig. Mark weit, rund.

VIII.—Knospen sitzend, von mehreren Schuppen umgeben; einjährige Zweige aufallend dick.

A.—*Z*weige mit Stacheln.

Aralia sinensis, *L.* Tara. *Taf. IV, Fig. 22.*

Knospen kegelig, locker beschuppt. Endknospe grösser als Seitenknospen. Schuppen graubraun, od. schwarzgraubraun. Die jungen *Z*weige graubraun, behaart, wie mit Baumwolle bedeckt. *Z*ahlreiche, weiche Stacheln auf der ganzen Oberfläche der *Z*weige. Blattnarbe schmal, u. lang, umfasst beinahe die ganze Triebe. Mark sehr weit, rund. Die Rinde harzig. Bei Verwundung fleisst eine durchsichtige Flüssigkeit aus.

Acanthopanax ricinifolium, *Sieb. et Zucc.* Hari-giri. *Taf. V, Fig. 1.*

Endknospe grösser als Seitenknospen, halbkugelig, etwas zugespitzt, od. kegelig, am Triebende dicht stehend. Seitenknospen keilförmig. Schuppen derb, dunkelcarminroth, glänzend. *Z*weige gelbgrün, teilweise grauweiss glänzend. *Z*ahlreiche, derbe gerade Stacheln an der ganzen Oberfläche der *Z*weige. Blattnarbe schmal, umfasst die Knospe. Mark weit, rundlich.

B.—*Z*weige ohne Stacheln.

a.—Knospen lang gestreckt, röthlich od. braun gefärbt.

Pirus sambucifolia, *Cham. et Sch.* Nanakamado. *Taf. V, Fig. 2.*

Knospen spindelig, lang. Endknospe grösser als Seitenknospen, die letzteren an die *Z*weige angedrückt, u. an der Spitze etwas gebogen. Schuppen dunkelroth glänzend. Die *Z*weige auf der Lichtseite braun, auf der Schattenseite graubraun, glänzend. Lent. gross, deutlich. Blattnarbe sehr schmal. Mark rund. Die Rinde hat einen eigenthümlichen Geruch.

b.—Knospen sitzend, grüngelb od. grau gefärbt.

Acanthopanax sciadophylloides, *Fr. et Sav.* Gonzetsu. *Taf. V, Fig. 3, 4.*

Knospen an der Spitze der Triebe dicht sitzend, kegelförmig, kurz. Schuppen grüngelb. Junge *Z*weige gerade,

grau gefärbt, mit grossen deutlichen Lenticellen versehen; die älteren grauweiss, dunkelblau gefleckt. Kurztriebe sehen wie grosse Seidenwürmer aus. Blattnarbe schmal u. lang. Mark gefächert. Die Rinde hat einen Geruch.

IX.—Knospen sitzend von mehreren Schuppen umgeben. Die Knospen stehen an der Spitze der Langtriebe einzeln od. an den Kurztrieben einzeln od. gehäuft.

A.—*Z*weige mit Stacheln, d. h. mit metamorphosirten Blatt- u. Haargebilden; dornspitzige *Z*weige nicht vorhanden.

a.—Je *Z*wei gerade Stacheln neben den Knospen.

b.—Gerade einfache od. verzweigte 3–5 spitzige Stacheln unter den Knospen.

Ribes grossularia, *L.* Gūsuberii.

Knospen schief abstehend, spindelig, schlank, von dünnen zugespitzten od. ausgefransten Knospenschuppen, nicht jedoch von Resten der Blattbasis umgeben. Die einjährigen *Z*weige sind hellgrau, die Oberhaut springt in Längsrissen auf, u. lässt darunter die graubraune, od. dunkelcarmine, glatte Rinde erkennen. Die Stacheln unter den Knospen meist zu drei beisammenstehend, seltner ist bloss ein Stachel vorhanden. Ausserdem können aber auch noch Stacheln auf der ganzen Oberfläche der *Z*weige vorkommen.

Berberis vulgaris, *L.* Hebinoborazu. *Taf. V, Fig. 6.*

Die Knospen von der stehenbleibenden Basis mehrerer Blätter umgeben. Die braunen Knospenschuppen sehen wie vertrocknet aus. *Z*weige lang ruthenförmig, dunkelbraungefärbt. Die Rinde nach dem Aufschneiden intensiv gelb gefärbt. Stacheln an der Spitze der Triebe in der Einzahl, an der übrigen Theilen verzweigt mit 3, 4 od. 5 Spitzen. Stacheln nur unter den Knospen. Mark ziemlich weit, gelblich gefärbt.

Berberis Thunbergii, *DC.* Megi. *Taf. V, Fig. 5.*

Die Knospen sind kugelig, locker beschuppt. Die schuppen braun. Die zahlreichen feinen *Z*weige übereinander hervortretend, dunkelrothbraun od. graubraun gefärbt. Die Stacheln

in der Einzahl, u. unterseits der Knospen. Die Rinde, Mark u. das Holz intensiv gelb gefärbt. Mark ziemlich weit.

c.—Meist Zwei od. nur eine noch rückwärts gebogene, derbe Stachel unter jeder Knospe.

Rosa multiflora, *Thunb.* No-ibara.

Knospen eiförmig, zugespitzt; die Schuppen glänzend roth. Die Zweige auf der Sonnenseite dunkelroth, auf der Schattenseite grün. Je zwei Stacheln unter jeder Knospe einige mm. entfernt. Lent. wenig. Mark weit.

Acanthopanax spinosum, *Miq.* Ukogi.

Knospen klein, halbkugelig, dicht sitzend. Zwei äussere, grössere, hellbraun gefärbte Schuppen umgeben die Knospe von beiden Seiten. Zweige graubraun, theilweise schwarz gefärbt, od. grau. Stacheln meist einzeln. Lent. gross, deutlich. Mark sehr weit. Rinde hat einen eigenthümlichen Geruch.

d.—Zahlreiche derbe, zurückgebogene Stacheln, ohne Zusammenhang mit den Knospen.

Rubus incisus, *Thunb.* Ki-ichigo.

Knospen eiförmig, zugespitzt, dunkelröthlich, teilweise schwarz. Zweige gerade, dunkelroth gefärbt, bereift. Blattnarbe schmal. Mark sehr weit.

B.—Zweige ohne Stacheln, mit od. ohne dornige Zweige.

a.—Knospenschuppen grün, teilweise braun gerändert.

α.—Knospen, besonders die unteren Seitenknospen klein.

Ficus erecta, *Thunb.* Inu-biwa. *Taf. V, Fig. 9, 10.*

Endknospe wesentlich grösser als Seitenknospen, spindel-od. kegelförmig. Seitenknospen spindelig, od. kugelig von mehreren Schuppen lose umgeben. Zweige grün. Blattnarbe gross, rundlich. Lent. wenig, deutlich. Mark weit.

Helwingia ruscifolia, *Willd.* Hanaikada.

Unter VI, *B.* b. *β.* beschrieben.

β.—Knospen gross, od- ziemlich gross.

1.—Knospen kugelig od. eiförmig.

Spiraea Thunbergii, *Sieb.* Hozaki-nanakamado.

Taf. V, Fig. 11, 12.

Knospen locker beschuppt. Zweige weisslich grau glänzend. Blattnarbe gross von unregelmässiger Form, gewölbt. Lent. wenig, deutlich. Mark sehr weit, hellbraun gefärbt.

2.—Knospen lang gestreckt.

Populus suaveolens, *Fisch.* Dero. *Taf. V, Fig. 13.*

Knospen spindelförmig lang, etwas kantig. Die Seitenknospen an der Spitze gekrümmt. Die Schuppen grün, theilweise braun, harzig, glänzend. Zweige graugrün od. graubraungrün, glänzend. Blattnarbe sichelförmig, schmal. Lent. wenig. Mark strahlenförmig, grünlich gefärbt.

b.—Knospen harzig, glänzend braun.

Populus tremula, *L.* **var. villosa,** *Wesm.* Yamanarashi.

Taf. V, Fig. 14.

Knospen spindelig, kurz, gerade od. nach innen gebogen. Die Schuppen braun glänzend, teilweise mit Harz bedeckt. Die jungen Zweige braun od. rothbraun, glänzend od. behaart; die älteren grau. Blattnarbe sichelförmig. Lent. deutlich. Mark fünfeckig.

Pirus aria, *Ehrh.* **var. Kamaonensis,** *Wall.* Urajironoki.

Taf. V, Fig. 21.

Knospen kegelig, (die Seitenknospen etwas abgeplattet), kurz, von mehreren Schuppen lose umhüllt. Die Schuppen dunkelbraun, glänzend od. gelbgrünlich. Zweige rothbraun, die älteren mit zahlreichen Kurztrieben. Blattnarbe sichelförmig, schmal. Lenticellen deutlich. Mark weit, rundlich.

Betula grossa, *Sieb. et Zucc.* Mizume. *Taf. V, Fig. 17.*

Knospen eiförmig zugespitzt, in der Mitte etwas hervorragend. Die Schuppen gelblichbraun, dunkelrothbraun gerändert, glänzend. Am Rande derselben ein wenig behaart. Einjährige Zweige hell- od. graulichrothbraun, glänzend, schwach behaart, die älteren dunkelrothbraun. Mark eng, eckig. Die Rinde hat einen eigenthümlichen Geruch.

Betula ulmifolia, *S. et Z.* Joguso-minebari. *Taf. V, Fig. 15, 16.*

Knospen ziemlich lang, spindelig. Die Schuppen dunkelrothbraun, glänzend. Blattnarbe flachdreieckig. Die Rinde hat einen eigenthümlichen Geruch.

Betula Maximowicziana, *Regel.* Saihada. *Taf. V, Fig. 18.*

Knospen eiförmig, zugespitzt od. spindelig. Die Schuppen gelbbraun, dunkel gerändert, glänzend, harzig. Einjährige Zweige schwach fein behaart, dunkelgelblichbraun, glänzend. Die rundlichen od. elliptischen Lenticellen sind deutlich. Mark sehr eng, eckig.

c.—Knospen roth, hell- od. dunkelbraun, od. graubraun, behaart od. nicht.

a.—Dornspitzige Zweige sind vorhanden.

*.—Knospen behaart.

Pirus japonica, *Thunb.* Boke. *Taf. V, Fig. 22.*

Knospen kegelförmig, kurz, flach, u. klein. Die Schuppen dunkelbraun behaart ; die Zahl der Schuppen ist gering. Einjährige Zweige braun bis grünbraun, die älteren dunkel- od. graubraun. Blattnarbe dreieckig. Lenticellen wenig. Mark rundlich.

Pirus sinensis, *Lindl.* Nashi. *Taf. V, Fig. 27.*

Endknospen meist grösser als Seitenknospen, kegelig. Die Schuppen dunkelrothbraun, behaart od. wenig behaart, weisslich bereift. Zweige grünlich braun, gerade. Blattnarbe dreieckig, schmal. Lent. ganz deutlich. Mark ziemlich weit, fünfeckig.

**.—Knospen nicht behaart.

Mespilus cuneata, *Sieb. et Zucc.* Sanzashi. *Taf. V, Fig. 23, 24.*

Knospen kugelig klein, an der Triebe fast senkrecht liegend, rothbraun, glänzend, grauweissgerändert. Schuppen zahlreich, aber etwas undeutlich. Junge Zweige braun, glänzend, ältere grau. Die Verzweigung dicht, die einzelnen Zweige von Zicksackform.

Glochidion obovatum, *Sieb. et Zucc.* Kankonoki.

Taf. VI, Fig. 1.

Knospen kugelig locker beschuppt, graubraun, sehr wenig behaart. Zweige hellbraun, vertrocknet aussehend. Die dornigen Zweige schwach. Lent. wenig. Mark ziemlich weit, eckig.

Prunus Mume, *Sieb. et Zucc.* Mume.

Knospen kegelförmig, kurz, dunkelröthlich gefärbt. Die jüngen Zweige grün, teilweisse röthlich, ältere grau od. gräulichbraun. Blattpolster hoch. Blattnarbe halbmondförmig. Mark weit, etwas eckig. Im Winter sind kugelige Blütenknospen vorhanden.

β.—Dornspitzige Zweige nicht vorhanden.

1.—Blattnarbe halbmondförmig, schmal.

a.—Knospen behaart.

Lindera glauca, *Bl.* Yama-kōbashi. *Taf. VI, Fig. 2.*

Knospen spindelig, ziemlich kurz, u. dick. Die Schuppen hellrothbraun, die inneren behaart, die äusseren nicht. Blattnarben halbkreisförmig. Die jüngen Zweige graubraun, glänzend. Lenticellen fein, wenig deutlich. Mark rund. Die Rinde hat einen eigenthümlichen Geruch.

Lindera umbellata, *Thunb.* Kanakuginoki. *Taf. VI, Fig. 6.*

Knospen spindelförmig, locker beschuppt, dunkelrothbraun, theilweise hellbraun gefärbt, schwach behaart. Blattnarbe halbmondförmig od. etwas rundlich. Die Rinde hat einen eigentümlichen Geruch.

Prunus persica, *Sieb. et. Zucc.* Momo.

Knospen eiförmig grünlich, filzig behaart. Zweige grün teilweise dunkelröthlich. Blattpolster vorspringend. Blattnarbe etwas klein, halbkreisförmig. Mark eckig (sechs).

Prunus tomentosa, *Thunb.* Yusuraume. *Taf. VI, Fig. 9.*

Knospen mit pfriemförmiger Schuppen neben der Basis, kegelförmig, zugespitzt, ziemlich lang, (Endknospen grösser als Seitenknospen, locker beschuppt). Seitenknospen von den Langtrieben abstehend. Die Schuppen dunkelröthlich, behaart.

Die jungen *Z*weige braun od. graulichbraun, dichtfilzig behaart. Mark klein, rund.

Liquidambar Maximowiczii, *Miq.* Fū. *Taf. VI, Fig. 7.*

Endknospen grösser als die Seitenknospen, spindelig. Die Schuppen carminrothbraun, teilweise hellbraun gerändert, seidenglänzend, schwach behaart. *Z*weige hellbraun, wenig behaart. Blattnarbe halbmondförmig, schmal. Mark eckig.

b.—Knospen unbehaart.

Pirus cathayensis, *Heml.* Kuarin. *Taf. VI, Fig. 10.*

Endknospen etwas kugelig, Seitenknospen dreieckig, gegen Triebe zu abgeplattet. *Z*wei grosse, glänzend braune Schuppen umgeben fast die ganze Knospe. Die einjährigen *Z*weige hellbraun, glänzend, schwach behaart, die älteren dunkelbraun. Blattpolster hoch. Blattnarbe sichelförmig. *Z*ahlreiche Kurztriebe sind vorhanden, fast gleich lang. Lent. wenig. Mark rund.

Orixa japonica, *Thunb.* Kokusagi. *Taf. VI, Fig. 11.*

Knospen zugespitzt, vierkantig, auf allen Vierseiten von Knospenschuppen umgeben, glänzend dunkelrothbraun gefärbt. *Z*weige graugrün, glänzend, auf der Schattenseite grün, auf der Lichtseite etwas dunkel. Blattnarbe halbmondförmig. Lent. deutlich. Mark von unregelmässiger Form. Die Rinde hat einen eigenthümlichen, unangenehmen Geruch.

Disanthus cercidifolia, *Max.* Beni-mansaku. *Taf. VI, Fig. 12.*

Knospen spindelig etwas geplattet. Mehrere glänzend dunkelrothen Schuppen umgeben, abwechselnd die Knospen von beiden Seiten. Blattnarbe halbmondförmig. *Z*weige hin- u. hergebogen, auf der Lichtseite dunkelröthlich. Lent. zahlreich, deutlich. Mark schmal, rundlich.

Kerria japonica, *DC.* Yamabuki.

Knospen spindelförmig, rothbraun, die Spitze etwas gebogen. *Z*weige grün, hin- u. hergebogen. Blattnarbe halbkreisförmig, schmal. Lent. deutlich. Mark sehr weit.

Lindera triloba, *Bl.* Shiromoji. *Taf. VI, Fig. 3.*

Knospen mit kugeligen Blütenknospen an der Basis, spin-

delig, gelblich od. grünlichbraun, dunkel gerändert. Zweige hin- u. hergebogen, auf der Lichtseite dunkelrothbraun, auf der Schattenseite grünlich gelb, die älteren dunkelgrau. Blattnarbe halbmondförmig. Mark weit. Die Rinde hat eigenthümlichen Geruch.

2.—Blattnarbe rundlich.

*.—Knospen kegel od. spindelförmig, ziemlich gross.

Lindera obutusiloba, *Bl.* Dankōbai. *Taf. VI, Fig. 13.*

Die Knospen meist mit kleinen Nebenknospen, rothbraun, glänzend, spindelig, die Spitze etwas gebogen. Die jungen Zweige auf der Lichtseite rothbraun, sonst gelblich grün, die älteren grau. Lenticellen deutlich. Mark sehr weit.

Lindera praecox, *Bl.* Aburachian. *Taf. VI, Fig. 14, 15.*

Knospen lang gestreckt, spindelig. Die Seitenknospen nach innen etwas gebogen. Die Seitenknospen dunkelrothbraun. Die jungen Zweige bräunlich grau glänzend wie lackiert. Lent. ziemlich deutlich. Die Rinde hat einen eigenthümlichen Geruch.

**.—Knospen sehr klein, kugelig.

3.—Blattnarbe dreieckig, schmal.

a.—Knospen behaart.

Prunus Miqueliana, *Maxim.* Higan-zakura.

Taf. VI, Fig. 16, 17.

Knospen spindelförmig, klein, an der Langtriebe gehäuft, od. auch nicht. Schuppen dunkelbraun, behaart. Blattpolster etwas vorspringend. Zweige schlank, die einjährige hellbraun behaart, die älteren schwarzbraun. Lent. deutlich. Mark rund.

Pirus Toringo, *Sieb.*, **var. incisa,** *Fr. et Sav.* Hime-kaidō.

Taf. V, Fig. 25, 26.

Knospen an der Langtriebe kegelförmig, kurz, dreikantig. Seitenknospen flach, an die Zweige gedrückt. Gewöhnlich 2-4 Schuppen sichtbar, glänzend rothbraun, weisslich bereift. Zweige dunkelröthlich braun, glänzend. Die Seitenzweige aus den Langtrieben fast senkrecht hervortretend, kurz, dorn-

spitzig. Mark rund. Nach Abschneiden der Zweige nimmt die Rinde u. das Mark eine gelblichbraune Färbung an.

b.—Knospen unbehaart.

Prunus Grayana, *Max.* Uwamizu-zakura. *Taf. VI, Fig. 19, 20.*

Die Endknospe kugelig, die Seitenknospen etwas flach, dunkelrothbraun gefärbt, glänzend. Blattpolster kugelig hervorgewölbt. Zweige ziemlich dick, die jüngeren dunkelbraun, teilweise weisslich, die älteren schwarzbraun, glänzend. Lent. deutlich. Mark rund. Die Rinde hat einen eigenthümlichen Geruch.

Prunus Buergeriana, *Miq.* Inu-zakura. *Taf. VI, Fig. 18.*

Endknospe kegelig, kurz, Seitenknospe etwas kugelig od. zugespitzt. Gewöhnlich 4 Schuppen sichtbar, dunkelrothbraun glänzend. Blattpolster ziemlich hoch. Zweige dunkelbraun, Stamm graubraun gefärbt. Mark rund, etwas gefärbt Die Rinde hat einen eigenthümlichen Geruch, stärker als die vorhergenannte Art.

Prunus Maximowiczii, *Rupr.* Mejiro-zakura. *Taf. VI, Fig. 23.*

Endknospen cylindrich zugespitzt; Seitenknospen eiförmig gespitzt; die Spitze schwach behaart. 6–7 Schuppen sichtbar, locker beschuppt, dunkelbraun, weisslich gefleckt. Junge Zweige grau, schmutzig, ältere glänzend dunkelbraun. Lent. deutlich. Mark etwas eckig.

Prunus cerasoides, *Max.* Chōji-zakura. *Taf. VI, Fig. 21, 22.*

Knospen an der Langtriebe gehäuft, spindelförmig, kurz, hellbraun od, dunkelbraun glänzend. Zweige hin- u. hergebogen, kurz. Die jüngeren Zweige glänzend bräunlichgrau, teilweise weisslich, die älteren hellbraun. Lent. deutlich. Mark rund.

Prunus pseudocerasus, *Lindl.* **var. spontanea,** *Maxim.*
Yama-zakura. *Taf. VI, Fig. 24.*

Knospen spindelig, an der Langtriebe gehäuft od. auch nicht. Die Schuppen dunkel- od. hellbraun, 6–8 sichtbar, locker beschuppt. Junge Zweige graubraun, ältere dunkelbraun. Mark 5 eckig.

Pyrus Miyabei, *Sargent.* Azuki-nashi. *Taf. V, Fig. 19, 20.*

Knospen eiförmig zugespitzt. Schuppen glänzend dunkelroth, am Rande braun, schwach behaart. Junge Zweige braun, ältere dunkelbraun glänzend. Kurztriebe eng geringelt. Lenticellen weissgrau, sehr deutlich. Mark ziemlich weit; von unregelmässiger Form.

Rubus trifidus, *Thunb.* Kaji-ichigo.

Knospen ziemlich gross, spindelig, etwas gekrümmt. Schuppen dunkelroth, am Rande schwach behaart. Zweige hin- u. hergebogen, auf der Lichtseite dunkelroth, glänzend, auf der Schattenseite grün. Blattnarbe dreieckig, schmal od. sichelförmig. Mark sehr gross, etwas gefärbt.

4.—Blattnarbe gross, herzförmig,

Platycarya strobilaceae, *Sieb. et Zucc.* Nobunoki.

Taf. VI, Fig. 25.

Endknospe grösser als Seitenknospe, zugespitzt, rothbraun, dunkelbraun gerändert. Zweige dick, graubraun, die jüngeren behaart, die älteren glänzend. Lent. fein, zahlreich. Mark weit, von unregelmässiger Form.

Euptelaea polyandra, *Sieb. et Zucc.* Fusa-zakura.

Taf. VII, Fig. 1.

Knospen eiförmig zugespitzt. Schuppen glänzend dunkelviolettbraun. Einige an der Basis der Knospe grauweiss behaart. Blattnarbe gross, umfasst beinahe die ganze Knospe. Junge Zweige braun, ältere graubraun. Lent. deutlich. Mark ziemlich eng. Zweige meist zweizeilig angeordnet.

X.—Knospen sitzend von mehreren Schuppen umgeben, an der Spitze der Langtriebe gehäuft.

A.—Knospen nicht von pfriemenförmigen Nebenblättchen umgeben.

Quercus glandulifera, *Bl.* Konara. *Taf. VII, Fig. 2.*

Knospen zugespitzt, fünfkantig, kahl, schief an der Triebe. Schuppen dunkelbraun, (seltner sind pfriemenförmige Schuppen an der Basis der Knospe vorhanden). Blatt-

narbe flachdreieckig, etwas vorspringend. Zweige grau, auf der Schattenseite hellbraun. Lent. ziemlich lang, hervortretend, sehr deutlich. Mark strahlenförmig.

Quercus grosseserrata, *Bl.* Mizunara. *Taf. VII, Fig. 3.*

Knospen zugespitzt, undeutlich fünfeckig, lang. Schuppen hellbraun. Zweige grünlich graubraun glänzend. Die obere, graue feine Haut leicht sich abschilfernd. Blattnarbe dreieckig od. halbmondförmig. Lent. weniger deutlich als bei Quercus glandulifera. Mark strahlenförmig.

Quercus serrata, var. variabilis, *Bl.* Abemaki. *Taf. VII, Fig. 5.*

Knospen kegelförmig, etwas kantig, wenig behaart (seltner mit pfriemenförmigen Schuppen versehen). Zweige grau, auf der Schattenseite graubraun.

Die vertrockeneten Laubblätter den ganzen Winter hindurch nicht abfallend. Lent. zahlreich, fein, breiter als lang. Das Aussehen des Quercus variabilis ist ähnlich wie die Q. serrata, aber die Knospenform ist wie bei der Q. glandulifera.

Quercus dentata, *Thunb.* Kashiwa. *Taf. VII, Fig. 4.*

Endknospe grösser als Seitenknospen, od. als die der vorgesetzten Arten, kegelig, fünfkantig. Seitenknospen etwas lang, die Spitze gebogen, über der Blattnarbe anfrecht stehend. Schuppen filzig behaart. Zweige dick, schwärzlichgrau bestäubt, schmutzig. Das dürre Laub bleibt den ganzen Winter an den Zweigen. Mark strahlenförmig.

B.—Endknospen von pfriemenförmigen Nebenblättchen umgeben.

Quercus serrata, *Thunb.* Kunugi. *Taf. VII, Fig. 6.*

Seitenknospen über der Blattnarbe stehend, einige derselben mit Nebenknospen. Zweige graubraun dichtfilzig behaart, mit Längsfurchen. Knospenschuppen graubraun, weniger behaart. Blattnarbe halbmondförmig, etwas vorspringend. Lent. deutlich. Mark strahlenförmig. Das dürre Laub bleibt den ganzen Winter hindurch.

XI.—Zweige kletternd, (Schlinggewächse).

1.—Knospen sind in der Blattachsel verborgen.

Actinidia arguta, *Planch.* Shira-kuchi. *Taf. VII, Fig. 7.*

Knospen hinter der Blattachsel verborgen, u. aus der hügeligen Wölbung des Zweiges hervortragend. Blattnarbe halbkreisförmig od. rundlich. Die jungen Zweige hell- od. dunkelbraun, die älteren graubraun, mit kürzeren Seitenzweige. Lenticellen lang, viel, deutlich. Mark gefächert, etwas gefärbt.

Actinidia polygama, *Miq.* Matatabi. *Taf. VII, Fig. 8, 9.*

Die Stelle der Knospen wie bei der vorigen Art. Blattnarbe halb-elliptisch, tief gewölbt. Junge Zweige schlank, langgestreckt, dunkelrothbraun glänzend. Lent. deutlich, etwas kurz. Mark gefächert, gefärbt.

Menispermum davuricum, *DC.* Kōmori-kazura.
Taf. VII, Fig. 10.

Knospen sind in der Blattnarbe verborgen, od. zwischen den Klüften sitzend, welche durch Rindenrisse an den Blattachseln entstehen. Zweige glänzend dunkelrothbraun. Blattnarbe gross, rundlich od. herzförmig, gewölbt. Lent. wenig zahlreich, deutlich. Mark weit, rundlich.

2.—Knospen sind von unausgebildeten od. zusammengedrückten Blättchen umgeben.

a.—Von unausgebildeten Blättchen.

Rhus toxicodendron, *L.* **var. radicans,** *Miq.* Tsuta-urushi.
Taf. I, Fig. 15.

Ein grosses, hellbraunfilzig behaartes, unausgebildeten Blättchen neben der Endknospe stehend. Seitenknospen flach, kleiner. Zweige graulichrothbraun mit vielen deutlichen Lenticellen, die älteren Zweige mit Luftwurzel versehen. Blattnarbe glänzend rothbraun, gefärbt. Mark weit, rundlich.

b.—Von zusammengedrückten Blättchen.

Coculus Thunbergii, *DC.* Ao-tsuzurafuji. *Taf. VII, Fig. 11.*

Knospen über der Blattnarbe sitzend. Die Zahl der zusammengedrückten Blättchen ganz undeutlich, dunkelgrau, dicht-

filzig behaart. *Z*weige schlank, grün- od. dunkelgrünlich braun, schwach behaart. Blattnarbe rundlich, gewölbt.

3.—Knospen mit einer bezw. zwei Schuppen umgeben.

A.—*Z*weige ohne Ranken.

Berchemia racemosa, *Sieb. et Zucc.* Kuma-yanagi.
Taf. VII, Fig. 15, 16.

Knospen über dem Blattpolster stehend, nur eine Schuppe umhüllt dieselbe vollständig von der Rückseite aus. Schuppen u. *Z*weige glänzend dunkelrothbraun, glatt. Lent. undeutlich. Mark rund, ziemlich weit.

Wistaria chinensis, *Sieb. et Zucc.* Murasaki-fuji.
Taf. VII, Fig. 12.

Knospen kegelförmig, gegen die Triebe zu abgeplattet. die Spitze etwas gekrümmt. Schuppen dunkelröthlichbraun, *Z*weige grau, glänzend. Blattpolster hochspringend, seitwärts mit kleinem Rindenansatz. Blattnarbe rundlich, od. halbmondförmig. Lent. deutlich. Mark weit, rundlich.

Wistaria brachybotrys, *Sieb. et Zucc.* Shiro-fuji.
Taf. VII, Fig. 13, 14.

Knospen eiförmig, zugespitzt, dunkelrothbraun. Blattnarbe halbmondförmig. *Z*weige dunkelbraun. Lent. undeutlich. Mark rundlich, weit.

B.—*Z*weige mit Ranken.

Vitis vinifera, *L.* Budō. *Taf. VII, Fig. 17.*

Knospen eiförmig. *Z*wei Knospen-Schuppen, die innere umhüllt fast die ganze Knospe, u. die äussere steht seitwärts; die letztere dunkelbraun gefärbt. *Z*weige von derselben Farbe, hin- u. hergebogen. Lent. undeutlich. Mark rund, etwas gefärbt.

Vitis flexuosa, *Thunb.* Gyōjanomizu. *Taf. VII, Fig. 18.*

Knospen eiförmig. *Z*weige schlank, graubraun glatt; Knospenschuppen von derselben Farbe. Blattnarbe undeutlich dreieckig. Mark rund, eng.

Vitis Thunbergii, *Sieb. et Zucc.* Ebizuru.

Knospen u. Zweige wie bei der vorigen Arten, aber davon leicht zu unterscheiden, durch die baumwolleartige Behaarung, welche die ganze Fläche der Zweige umfasst.

4.—Knospen von mehreren Schuppen umgeben.

α.—Knospen spindelförmig.

Schizandra chinensis, *Baill.* Chōsen-gomishi.

Taf. VII, Fig. 19.

Knospen spindelig, von mehreren Schuppen spiralig umgeben. Schuppen tiefrothbraun; Zweige von derselben Farbe auf der Lichtseite graulich. Blattnarbe halbmondförmig. Lent. sehr deutlich. Mark weit, rund. Die Rinde hat einen eigenthümlichen, angenehmen Geruch.

β.—Knospen kugel- od. eiförmig.

Akebia quinata, *Decne.* Akebi. *Taf. VII, Fig. 20.*

Knospen eiförmig, zugespitzt. Zwei od. drei derselben beisammensitzend, locker beschuppt, dunkelbraun. Zweige dunkelbraun, die älteren graubraun, glänzend. Lent. sehr deutlich, zahlreich. Mark eng.

Akebia lobata, *Decne.* Mitsuba-akebi. *Taf. VII, Fig. 21.*

Knospen eiförmig, dunkelbraun. Seitwärts der grösseren Knospen, die kleineren beisammensitzend. Blattpolster hoch. Zweige braun od. hellbraun, glänzend. Lent. deutlich, weniger zahlreich als bei Akebia quinata. Mark rund.

Celastrus articulatus, *Thunb.* Tsuru-umemodoki.

Taf. VII, Fig. 22.

Knospen kugelig, an der Triebe senkrecht stehend, dunkelbraun gefärbt. Zweige, gerade, graubraun. Blattnarbe halbmondförmig. Lent. klein, zahlreich. Mark rund.

TABELLE II.

Knospen stehen an der Langtrieben abwechselnd,
" Zweizeilig.,,

I.—Knospen (Laub od. Blüten) gestielt, u. von wenigen Schuppen umgeben.

A.—Knospen kugelig od. eiförmig.

Corylopsis pauciflora, *Sieb. et Zucc.* Hiuga-mizuki.

Taf. VIII, Fig. 1.

Blütenknospen eiförmig od. kugelig, gestielt. Die äusseren Schuppen glänzend hellbraun u. leicht ablösbar, die inneren auf der Lichtseite hellröthlich, sonst grün. Zweige schlank, die jüngeren braun glänzend, die älteren graubraun. Lent. deutlich. Blattnarbe klein, dreieckig. Mark eng.

B.—Knospen spindelig od. kegelförmig.

Corylopsis spicata, *Sieb. et Zucc.* Tosa-mizuki.

Taf. VIII, Fig. 2.

Blütenknospen lang gestreckt, spindelig. Die äusseren Schuppen leicht ablösbar, die inneren auf der Lichtseite röthlich, od. intensivroth glänzend, sehr schön, sonst gelbgrün. Zweige hin- u. hergebogen, die jüngeren glänzend graubraun, die älteren etwas dunkler. Blattnarbe ziemlich gross, dreieckig. Mark rund.

C.—Knospen etwas flach.

Stuartia monadelpha, *Sieb. et Zucc.* Saruta,

Taf. VIII, Fig. 3, 4.

Knospen etwas flach, von beiden Seiten beschuppt, scharfkantig, hellgrau, braun behaart. Zweige schlank, besenförmig. Der Stamm braun, glänzend, glatt. Lent. deutlich. Mark rund.

Stuartia pseudo-Camellia, *Max.* Natsu-tsubaki.

Taf. VIII, Fig. 5.

Knospen spindelig, etwas abgeflacht. Die äusseren Knospenschuppen dunkelbraun, leicht ablösbar, die inneren

grüngrau, filzig behaart. *Z*weige hin- u. hergebogen; die Peridermschichten reissen faserig auf. Die Färbung der einjährigen u. mehrjährigen *Z*weige deutlich verschieden. Mark rund, etwas weit.

II.—Knospen kugelig, keil- od. eiförmig, mit zwei od. weinigen Schuppen.

A.—Knospen äusserlich von einer grossen umfassenden, u. einer kleineren Schuppe umgeben.

Tilia cordata, *Mill.* **var. japonica,** *Miq.* Shinanoki.

Taf. VIII, Fig. 8.

Knospen eiförmig zugespitzt, etwas gekrümmt, Endknospen grösser als Seitenknospen u. von unregelmässiger Form, dunkelrothlich, kahl. *Z*weige etwas gebogen, die einjährigen hellbraun, auf der Lichtseite röthlich, glänzend, die älteren dunkelgrauroth. Blattnarbe halbmondförmig. Mark schmal.

Tilia Miqueliana, *Max.* Bodaiju. *Taf. VIII, Fig. 6, 7.*

Knospen kugelig zugespitzt, zwei Seiten derselben abgeflacht, gelbgrün schwach behaart, an der Triebe schief anbiegend, u. gebogen. Einjährigen *Z*weige gelbgrün, kurz behaart, die älteren graubraun. Mark rund.

B.—Knospen von mehreren Schuppen umgeben.

a.—Knospen behaart.

Celtis sinensis, *Pers.* Enoki. *Taf. VIII, Fig. 9.*

Knospen keilförmig, flach an der Trieb angedrückt, mit zwei pfriemenförmigen Blättchen an der Basis. *Z*wei Knospenschuppen sichtbar, schwärzlichgrau behaart. Die einjährigen *Z*weige dicht behaart, dunkelgraubraun. Blattpolster hoch. Lent. deutlich. Mark rund.

Corylus heterophylla, *Fisch.* Hashibami.

Taf. VIII, Fig. 12, 13.

Knospen eiförmig, die vordere u. hintere Seite etwas abgeflacht, dunkelrothbraun, am Rande schwach behaart, sonst kahl. Die jüngere Triebe röthlichbraun, bereift. Im Winter mit röthlichbraun gefärbten Blütenkätzchen. Blattpolster hoch. Blattnarbe abgerundet dreieckig. Mark rund, eng.

Corylus rostrata, *Ait.* **var. Sieboldiana,** *Max.*

Tsuno-hashibami. *Taf. VIII, Fig. 11.*

Knospen kugelig, zugespitzt. Die Spitze u. der Rand der Schuppen behaart, dunkelroth gefärbt. Zweige grau, in den ersten Jahren sehr dicht behaart. Kätzchen grösser als bei Corylus heterophylla 2.5–3.5 cm. lang, graubraun gefärbt. Blattnarbe halbmondförmig. Mark unregelmässiger Dreieckig, eng.

β.—Knospen nicht behaart.

Castanea vulgaris, *L.* **var. japonica,** *DC.* Kuri.

Taf. VIII, Fig. 14.

Knospen kugelig, zugespitzt, rückwärts etwas flach. Schuppen glänzend dunkelrothbraun. Zweige von derselben Farbe. Blattnarbe dreieckig. Lenticellen, weiss, deutlich. Mark strahlenförmig. Der Holztheil der jüngeren Zweige nimmt eine unregelmässige Form an.

III.—Knospen spitz, walzenförmig, spindel- od. kugelförmig, mit zahlreichen Schuppen.

A.—Schuppen spiralig angeordnet.

α.—Knospen spindelig.

Fagus sylvatica *L.* **var. Sieboldi,** *Max.* Buna.

Taf. VIII, Fig. 16, 17.

Knospen spindelig. Schuppen hellbraun bis dunkelgraubraun, die Spitzen derselben sehr fein behaart, weisslich. Zweige hin- u. hergebogen, die jüngeren graubraun grünlich, die älteren weissgrau. Der Stamm hat eine grauweisse Färbung. Lent. deutlich. Mark von unregelmässiger Form.

Fagus japonica, *Max* Inu-bara. *Taf. VIII, Fig. 15.*

Knospen sehr lang gestreckt bis 3 cm. lang, spindelförmig, zumeist lang gestielt. Schuppen von derselben Farbe wie bei F. sylv. var. Sieboldi, aber ein wenig grau. Zweige schlank hin- u. hergebogen, glatt, in der Jugend hellrothbraun, später grau. Kurztriebe eng eingeschnürt. Mark unregelmässig eckig.

β.—Knospen kegelförmig.

Ilex macropoda, *Miq.* Aohada. *Taf. IX, Fig. 1, 2.*

Knospen kegelig, kurz an der Triebe dicht stehend, locker beschuppt. Knospenschuppen u. einjährige Zweige hellbraun, die älteren glänzend dunkelgrau Kurztriebe eng eingeschnürt. Lent. deutlich. Mark rund.

Ginkgo biloba, *L.* Ichō. *Taf. IX, Fig. 3, 4.*

Knospen kegelförmig, kurz, Schuppen braun. Die jüngen Zweige hell- od. graubraun glänzend, die älteren weisslichgrau. Blattnarbe halbmondförmig. Lent. undeutlich. Mark unregelmässig. Zweige mit langen, eng eingeschnürten Kurztriebe.

γ.—Knospen spitz, walzenförmig.

Ostrya virginica, *Willd.* Asada. *Taf. IX, Fig. 15, 16.*

Knospen walzenförmig, zugespitzt od. eiförmig. Knospenschuppen braun, od. dunkelröthlichbraun, teilweise gelblichgrün, glänzend. Zweige dunkelröthlichbraun od. hellbraun mit deutlichen Lenticellen. Blattnarbe halbmond- od. sichelförmig. Mark eng und von unregelmässiger Form.

B.—Schuppen abwechselnd stehend.

a.—Schuppen auf zwei Seiten angeordnet.

*.—Knospen behaart.

Aphananthe aspera, *Planch.* Mukunoki. *Taf. VIII, Fig. 10.*

Knospen spindelig, zugespitzt etwas flach, gekrümmt, mit kleinen Nebenknospen an der Trieben gedrückt, locker beschuppt, dunkelbraun grauweiss behaart. Zweige schlank, besenförmig, dunkelgrau, in der Jugend grauweiss, dicht behaart. Mark rund.

**.—Knospen gar nicht od. wenig behaart.

Ulmus campestris, *Sm.* **var. vulgaris,** *Planch.* Kobu-nire. *Taf. IX, Fig. 5, 6.*

Knospen klein kugelig, etwas abgeflacht, Schuppen schwärzlichbraun. Die jungen Zweige graubraun od. braun behaart, die älteren grau. Die mehrjährigen Triebe zeichnen sich durch tiefe Risse in der Epidermis aus.

Ulmus parvifolia, *Jacq.* Aki-nire.

Knospen meist zu zwei beisammen sitzend, eiförmig, zugespitzt, etwas abgeflacht, dunkelbraun. Zahlreiche, dünne fast gleich lange, braune Seitenzweigen entwickeln sich aus der Triebe. Lenticellen deutlich. Mark klein.

Ulmus campestris, *Sm.* **var. laevis,** *Planch.* Haru-nire.

Taf. IX, Fig. 8, 9.

Knospen kegelig, flach gekrümmt, 3–5 mm. lang, grau od. dunkelbraun, schwach behaart. Zweige graubraun, dicker als bei anderen Ulmusarten; die jüngeren ein wenig behaart. Blattnarbe ziemlich gross, halbmondförmig. Mark rund, klein.

Ulmus montana, *Sm.* **var. laciniata,** *Trautv.* Atsushi.

Taf. IX, Tig. 7.

Endknospe etwas grösser als Seitenknospen, die letzteren sind von verschiedener Form, spindelförmig, zugespitzt glänzend schwarzbraun. Zweige hin- u. hergebogen, auf der Lichtseite graubraun glänzend, sonst grau. Blattnarbe ziemlich gross, halbmondförmig. Mark klein, rund.

Die Rindenfaser aller zu dieser Gruppe gehörigen Holzarten ist meist ziemlich stark, u. das Holz biegsam.

b.—Schuppen von vier Seiten abstehend.

Carpinus japonica, *Bl.* Kuma-shide. *Taf. IX, Fig. 10.*

Knospen spindelig, etwas kantig, schlank u. scharf zugespitzt. Schuppen hell- od. dunkelbraun glänzend. Zweige schlank, hin- u. hergebogen, glänzend dunkelbraun. Lent. deutlich. Mark rund.

Carpinus jedoensis, *Max.* Inu-shide. *Taf. IX, Fig. 11.*

Die Spitze der Knospen etwas gebogen, spindelig, vierkantig, dicker als bei Carpinus japonica. Schuppen hellrothbraun glänzend. Die einjährigen Zweige filzig behaart, grünlichgrau.

Carpinus laxiflora, *Bl.* Soro. *Taf. IX, Fig. 13.*

Knospen spindelig etwas dick u. kurz, vierkantig. Die jungen Zweige kahl, od. graugrün behaart. Der Stamm grauweiss.

Carpinus cordata, *Bl.* Sawa-shiba. *Taf. IX, Fig. 12.*

Endknospe 12 mm. lang, grösser als Seitenknospen; beide grösser als bei anderen Carpinusarten, spindelig, vierkantig-die Spitze behaart. Knospenschuppen hellbraun, dunkel gerändert. Die jüngen Zweige graubraun, die älteren grau. Lent. deutlich. Mark eckig.

Zelkowa acuminata, *Planch.* Keyaki. *Taf. IX, Fig. 14.*

Knospen zumeist zwei beisammen dicht stehend, kegelförmig, kantig. Schuppen dunkel- od. schwärzbraun, am Rande ein wenig behaart. Zweige schlank, hin- u. hergebogen, braun od. dunkelbraun. Blattnarbe elliptisch. Lent. rund, deutlich. Mark rund.

IV.—Knospen von zusammengedrückten Blättchen gebildet (nackt).

Picrasma quassioides, *Benn.* Nigaki. *Taf. IX, Fig. 19.*

Zwei unausgebildete Blättchen umfassen die Knospe, flach, halbmondförmig, od. quadratisch, gelblich dunkelbraun, filzig behaart. Blattnarbe gross, halbmondförmig od. rundlich. Zweige dunkelbraun, graulich. Lent. zahlreich, sehr deutlich. Mark etwas weit. Die Rinde von bitterem Geschmack.

Hamamelis japonica, *Sieb. et Zucc.* Mansaku.

Taf. IX, Fig. 17, 18.

Zwei unausgebildete Blätttchen beisammen stehend, wovon das eine lang gestreckt, scalpelförmig, lang gestielt. Sie sind dicht filzig behaart, auf der Lichtseite dunkelgrau, sonst hellbraun. Lent. ziemlich gross, deutlich. Blattnarbe halbkreisförmig od. abgerundet dreieckig.

TABELLE III.

Knospen "gegenständig."

I.—Die Knospen sind in der Blattnarbe verborgen.

Philadelphus coronarius, *L.* **var. Satumi,** *Max.* Baikwa-utsugi. *Taf. X, Fig. 1, 2.*

Blattnarbe dreieckig weissgrau, etwas vorspringend, in der Mitte eine kleine Vorwölbung zeigen, unter welcher die Knospe verborgen ist. Die jungen *Z*weige gerade, braun etwas glänzend pfeifenrohrartig, sieht ganz dürr aus, die älteren braungrau. Lenticellen undeutlich. Mark weit, rund.

II.—Zweige auffallend dick, Endknospen sehr gross.

Aesculus turbinata, *Bl.* Tochinoki. *Taf. X, Fig. 3.*

Endknospe 1 cm. Durchmesser, eiförmig, zugespitzt etwas gebogen; die Seitenknospen kugelig, dunkelbraun sehr harzig. Blattnarbe gross hellbraun gefärbt. An der Grenze der jungen- u. älteren *Z*weige ringförmige Einschnürung. Lent. deutlich. Mark weit, rund u. braun gefärbt.

III.—Die Zweige sind zumeist dornspitzig.

Punica Granatum, *L.* *Z*akuro. *Taf. X, Fig. 6, 7.*

Knospen klein pyramidenförmig, kurz, röthlichbraun. *Z*weige graubraun sehr schlank. Die oberen Peridermschichten lösen sich in Fasern ab. Lenticellen deutlich. Mark ziemlich weit, rund.

Rhamnus japonica, *Max.* **var. genuina,** *Max.* Kuro-umemodoki. *Taf. X, Fig. 4, 5.*

Knospen an der Triebe angedrückt, pyramidenförmig, ziemlich lang, etwas gebogen. Schuppen dunkelbraun, am Rande ein wenig behaart. Blattnarbe hoch, seitwärts pfriemenartige Blättchen hervortretend. Die dornspitzigen *Z*weige derb, hellgrau od. braungrau, glänzend. Die älteren *Z*weige dunkelbraun. Blattnarbe halbmondförmig od. sichelförmig. Die Rinde hat einen eigentümlichen Geruch. Knospen oft nicht gegenständig angeordnet.

IV.—Knospen von unausgebildeten Blättchen, nicht von eigentlichen Schuppen umgeben.

A.—Knospen gestielt.

a.—*Z*weige (zweizeilig angeordnet) grau gefärbt.

Callicarpa mollis, *Sieb. et Zucc.* Yabu-murasaki.

Taf. X, Fig. 8.

Knospen sehr lang gestielt, kleinwalzig; Endknospe grösser als Seitenknospen, die letzteren schmal, gekrümmt. *Z*weige schlank, grünlich grau. Blattnarbe rundlich. Lent. undeutlich. Mark sehr weit, 6 kantig.

Callicarpa japonica, *Thunb.* Murasakishikibu. *Taf. X, Fig. 10.*

Knospen kurz gestielt, graubraun kleinwalzig. *Z*weige schlank, graubraun. Mark weit, rundlich.

Callicarpa purpurea, *Juss.* Ko-murasaki. *Taf. X, Fig. 9.*

Knospen zumeist kugelig, sehr kurz gestielt, (seltner lang gestielt) kleinwalzig. Lent. wenig, deutlich. Mark weit, 4 kantig.

b.—*Z*weige braun gefärbt.

Viburunum furcatum, *Bl.* Mushikari. *Taf. X, Fig. 11, 12.*

*Z*wei lang gestreckte, unausgebildete, braun behaarte Blättchen umfassen die Knospe. *Z*weige gerade, lang, grünbraun, glänzend. Blattnarbe abgerundet dreieckig, mit 3 Gefässbundelspuren. Lent. wenig. Mark ziemlich weit.

B.—Knospen dicht an den Trieben sitzend.

Clerodendron trichotomum, *Thunb.* Kusagi. *Taf. X, Fig. 13.*

*Z*wei unausgebildete Blättchen umfassen die Knospe. Die letztere an der Triebe fast senkrecht stehend, braunviolett, dicht behaart. *Z*weige ziemlich dick, auf der Lichtseite dunkelgraubraun, sonst grau, glänzend. Blattnarbe gross. Lent. fein, sehr deutlich. Mark sehr weit, gefärbt.

Cornus ignorata, *Koch.* Kumano-mizuki. *Taf. X, Fig. 14, 15.*

Endknospe (von zwei unausgebildeten Blättchen gebildet) grösser als Seitenknospen, keilförmig, lang gestreckt. Die letzteren nadelförmig, von der stehenbleibenden Blattbasis umgeben, dunkelgrau behaart. *Z*weige auf der Lichtseite

röthlich, sonst gelblichgrün, 6 kantig. Lent. wenig. Mark rundlich, od. 6 kantig.

Premna microphylla, *Turcz.* Hama-kusagi. *Taf. X, Fig. 16.*

Knospen kugelig etwas gespitzt, hellbraun. Seitenknospen flach. Die einjährigen Zweige gerade, lang, hellbraun. Blattpolster vorspringend. Blattnarbe halbkreisförmig, gewölbt. Mark ziemlich weit, elliptisch. Durch einen besonderen Geruch ausgezeichnet.

Vitex Negundo, *L.* Ninjinboku. *Taf. X, Fig. 17.*

Knospen sind unter der Blattachsel verborgen, so dass man die Zahl der Blättchen nicht wahrnehmen kann, graubraunfilzig behaart. Die einjährigen Zweige viereckig, graubraun, gerade u. lang. Blattnarbe sichelförmig. Lent. klein, deutlich. Mark 4 kantig.

Vitex trifolia, *L.* **var. unifoliolata,** *Schauer.* Hamabō.

Knospen klein, etwas entfernt oberhalb der Blattnarbe stehend, grau behaart. Die jüngeren Theile der Zweige dicht behaart wie mit Sammet bekleidet, graubraun, 4 bis 5 kantig. Mark weit, eckig. Kriechender Strauch nicht aufrecht stehend.

Evodia rutæcarpa, *Benth. et Hook.* Goshiyu. *Taf. X, Fig. 18, 19.*

Knospen flach, viereckig, hellbraunfilzig behaart. Zweige ziemlich dick, gerade, dunkelcarmin roth, der jüngere Theil schwach behaart. Blattnarbe gross halbmondförmig, oft ziemlich breit, meist mit 3 Gefässbündelspuren versehen. Lent. ganz deutlich. Mark weit, eckig. Holz u. Rinde gelblich.

V.—End- u. Seitenknospen so von zwei Schuppen dicht umgefasst, dass scheinbar nur eine Knospenschuppe vorhanden ist.

A.—Knospen unbehaart, glänzend.

a.—Knospen gestielt.

Viburnum opulus, *L.* Kanboku. *Taf. X, Fig. 20.*

Knospen dem Stengel angedrückt, auf der Aussenseite kugelig gewölbt, zugespitzt. Schuppen grünlich od. röthlichbraun. Endknospe fehlt meist. Seitenzweige lang, nicht

abstehend, mehr od. weniger kantig. Junge Triebe braun, ältere grau. Mark weit, eckig.

Acer rufinerve, *Sieb. et Zucc.* Uri-kaede. *Taf. X, Fig. 22.*

Endknospe grösser als Seitenknospe, 4 kantig, zugespitzt. Seitenknospen eiförmig, lang gestreckt, etwas gekrümmt. Schuppen dunkelröthlich, glänzend. Zweige gerade, lang, gelblichgrün, auf der Lichtseite röthlich, die älteren grün, mit viereckigen, weissen Flecken versehen. Blattnarbe schmal, mit 3 Gefässbündelspuren. Lenticellen wenig. Mark weit, rundlich.

Acer cratægifolium, *Sieb. et Zucc.* Meuri-kaede.
Taf. X, Fig. 23, 24.

Knospen eiförmig, zugespitzt; die Seitenknospen an der Triebe angedrückt, meist mit einem Schuppenrisse auf dem Rücken, kurz gestielt, dunkelröthlich. Zweige auf der Lichtseite gelblichgrün od. röthlich, schwärzlich bekleidet. Mark rund.

b.—Knospen sitzend.

Staphylea bumalda, *Sieb. et Zucc.* Mitsuba-utsugi.
Taf. X, Fig. 21.

Knospen keilförmig, rückwärts etwas gewölbt. Am Ende der Triebe stehen immer je zwei Knospen beisammen. Schuppen schwarzbraun. Zweige im ersten Jahre glänzend dunkelbraun, die älteren graubraun, feinrissig. Blattnarbe schmal, herzförmig, od. dreieckig. Lent. lang, deutlich. Mark weit, rund.

Acer palmatum, *Thunb.* Kaede. *Taf. X, Fig. 25, 26.*

Zwei od. drei Endknospen beisammensitzend, kegelförmig, kurz, dunkelröthlich gefärbt. Zweige gelblichgrün, auf der Lichtseite röthlich. Die stehenbleibende Korkschichte in der Blattnarbe umhüllt die Knospenbasis. Lenticellen undeutlich. Mark etwas weit, rund.

Salix multinervis, *Fr. et Sav.* Kori-yanagi. *Taf. III. Fig. 7.*

Zahlreiche Knospen an der Triebe angedrückt, kegelig, klein. Blütenknospen eiförmig, zugespitzt, die Spitze etwas gekrümmt, gestielt. Zweige u. Schuppen glänzend roth, der ältere Theil der Zweige hellbraun. Blattnarbe sichelförmig.

Salix rubra, *L.* Saruko-yanagi. *Taf. III, Fig. 10.*

Laubknospen spindelig, schlank, angeplattet. Blütenknospen spindelförmig, lang; die Spitze gekrümmt. Die Knospe u. Zweige auf Lichtseite roth, sonst gelblich grün.

B.—Knospen behaart.

Phellodendron amurense, *Rupr.* Kiwada. *Taf. X, Fig. 28.*

End- u. Seitenknospe gleich gross, in der Mitte der Blattnarbe sitzend, von zwei Schuppen dicht umhüllt, hügelförmig, dunkelbraun filzig behaart. Zweige sehr dick, gerade, die jüngeren hellgelblichbraun od. grau. Blattnarbe fusssohlenförmig. Mark gross, rund, etwas gefärbt. Die Rinde zeichnet sich durch gelbe Färbung aus.

Acer cissifolium, *Koch.* Mitsude-kaede. *Taf. X, Fig. 27.*

Endknospe von zwei kleineren Seitenknospen umgeben. Seitenknospe an den Zweigen abgeplattet, von der Gestalt eines Käfers. Knospenschuppen u. junge Triebe grünlich, teilweisc grauweiss, die älteren Triebe glänzend grau. Blattnarbe schmal. Mark etwas weit.

Cornus Kousa, *Buerg.* Yamaboshi. *Taf. X, Fig. 30, 31.*

Knospen nur am Ende der Triebe, kegelig. Zwei dunkelviolettbraun filzig behaarte Schuppen dicht zusammentretend. Blütenknospen kugelig, zugespitzt, mit mehr als zwei Schuppen versehen. Blattnarbe schmal, umfasst die Knospe ringsum. Zweige gerade, lang, dunkelbraun, teilweise weisslich, mit zahlreichen, deutlichen Lenticellen. Mark eng.

Cornus officinalis, *Sieb.* Sanshiyu.
Taf. X, Fig. 29, u. Taf. XI, Fig. 1.

Endknospe grösser als Seitenknospen, zugespitzt, kantig, grau behaart. Die einjährigen Zweige 4 kantig, rothbraun, weisslich bereift, ein wenig behaart. Blattpolster etwas vorspringend. Blattnarbe dreieckig. Mark rund.

VI.—Seitenknospen eiförmig oder spindelig, fast senkrecht abstehend.

Lonicera Morrowii, *A. Gray.* Kinginboku. *Taf. XI, Fig. 4.*

Knospen eiförmig, etwas kantig, locker beschuppt. Schup-

pen filzig behaart, hellbraunlich. Endknospe einzeln. *Z*weige ziemlich dünn, hellgrau, kahl. Die oberen Peridermschichten lösen sich in Fasern ab. Mark innen hohl, am Rande braun.

Lonicera glacilipes, *Miq.* Uguisukagura. *Taf. XI, Fig. 2, 3.*

Endknospe grösser als Seitenknospen, eiförmig zugespitzt, etwas kantig. Knospenschuppen dünnhäutig, grau od. graubraun. *Z*weige schlank, auf der Lichtseite grau, auf der Schattenseite hellbraun. Diese Art zeichnet sich aus durch die stehendenbleibenden, braunen halbkreisförmigen Blättchen, welche die Triebe ringsum umfassen. Mark rund.

Lonicera coerulea, *L.* Kuromino-uguiskagura.

Endknospe wie bei der Lon. gracilipes, locker beschuppt. Seitenknospen etwas flach, u. zwei übereinander von *Z*weige abstehend. *Z*weige schlank, glänzend gelblich rothbraun; die äusseren Korkschichten lösen sich faserig ab. Blattbasis sehr hoch vorspringend, schuppenartig. Mark weit, etwas kantig.

VII.—An den Seitenknospen nur wenige Schuppen (2 od. 3) sichtbar.

A.—Seiten- (End) knospen kantig.

a.—Knospen od. *Z*weige behaart, od. kleinwalzig.

Viburnum dilatatum, *Thunb.* Gamazumi. *Taf. XI, Fig. 5.*

Endknospe vierkantig, zugespitzt. Seitenknospen flach, an der Triebe angedrückt, filzig behaart, rothbraun. *Z*weige auf der Lichtseite graubraun, kleinwalzig. Blattnarbe schmal. Mark weit, rund.

Viburnum Sieboldi, *Miq.* Gomaki. *Taf. XI, Fig. 7.*

Knospen vierkantig, zugespitzt, länger gestreckt als bei der vorigen Art, rothbraun schwach behaart. *Z*weige dunkelgrau behaart. Blattnarbe gross, von der Gestalt einer fliegenden Fledermaus. Mark rund. Die Rinde hat einen specifischen unangenehmen Geruch.

Viburnum tomentosum, *Thunb.* Yabu-demari. *Taf. XI, Fig. 6.*

Knospen walzenförmig, lang gestreckt, zugespitzt, etwas kantig. Seitenknospen etwas gekrümmt. Schuppen u. junge *Z*weige kleinwalzig, nicht behaart. *Z*weige graubraun, Blattnarbe schmal. Mark rund.

Viburnum Wrightii, *Miq.* Miyamagamazumi.

Taf. XI, Fig. 8, 9.

Endknospe grösser als Seitenknospe, vierkantig zugespitzt. Zwei lockere Schuppen an der Basis der Knospe. Die Blütenknospe am Triebende vergekehrt kegelförmig. Schuppen dunkelröthlich, kleinwalzig. Zweige gerade, graurothbraun. Blattnarbe schmal. Lent. deutlich, gering.

b.—Knospen nicht od. wenig behaart.

Fraxinus Sieboldiana, *Bl.* Shioji. *Taf. XI, Fig. 12.*

Zwei kleinere Knospen umgeben die Endknospe, die letztere wesentlich grösser als die Seitenknospen, vierkantig, kurz. Schuppen derb, gekielt, dunkelbrau, an der Basis weiss mehlig. Blattnarbe schmal, umfasst fast die ganze Knospe. Zweige sparrig, hellgraugrün. Lent. ganz deutlich, lang. Mark weit, rund.

Fraxinus Bungeana, *DC.* **var. pubinervis,** *Bl.* Toneriko.

Taf. XI, Fig. 10, 11.

Knospen ähnlich wie bei der Fr. Sieboldiana; äussere zwei Schuppen in der Mitte der Knospe meist frei zusammentretend. Die jungen Zweige etwas kantig (4), gerade, an der Basis gewölbt, dunkelbraun, gelb, teilweise weiss gefleckt. Lent. undeutlich. Mark undeutlich viereckig.

Fraxinus longicuspis, *Sieb. et Zucc.* Kobano-toneriko.

Taf. XI, Fig. 13.

Endknospen etwas grösser als die Seitenknospen, weniger scharf kantig, etwas flach. Seitenknospen fast senkrecht abstehend. Schuppen schwärlich bereift. Zweige grau, rundlich; Blattpolster etwas gewölbt. Blattnarbe halbmondförmig. Lent. fein, zahlreich. Mark eng, eckig.

Chionanthus retusa, *Lindl. et Paxt.* Hitotsubatago.

Taf. XI, Fig. 14.

Endknospe grösser als Seitenknospe schaf 4 kantig, kurz. Schuppen dunkelbraun Zweige dünner als die der vorigen Arten, fast senkrecht abstehend, braungrau. Blattpolster hoch. Blattnarbe halbelliptisch. Lent. deutlich, rund. Mark eng.

B.—Seitenknospen angedrückt, an der dem Zweige zugewendeten Seite abgeplattet.

a.—Knospen u. Zweige nicht behaart.

α.—Blattnarbe schmal.

Acer argutum, *Maxim.* Asanoha-kaede. *Taf. XI, Fig. 17, 18.*

Knospen am Triebende gehäuft, die Mittelern lang gestreckt, von zwei Schuppen dicht umhüllt, grösser als die übrigen. Seitenknospen von der Gestalt eines Käfers. Schuppen u. einjährige Zweige dunkelröthlich, dicht bereift, ältere Zweige gelblich, auf der Lichtseite röthlich. Zwei schmale Blattnarben zusammenstossend. Lent. wenig. Mark rund.

Acer distylum, *Sieb. et Zucc.* Hitotsuba-kaede.
Taf. XI, Fig. 15, 16.

Eine grössere Endknospe mit zwei kleineren Seitenknospen seitwärts, käfergestaltig. Unausgebildete Blättchen umgeben häufig die Knospe. Knospenschuppen u. Zweige dunkelroth, graubraunfilzig behaart. Blattnarbe schmal, je zwei zusammenstossend. Mark rund.

Cercidiphyllum japonicum, *Sieb. et Zucc.* Katsura.
Taf. XI, Fig. 19.

Am Ende der Triebe zwei Knospen beisammen abstehend, End- u. Seitenknospen gleich gross, kegelig. Eine an dem Zweige abgeplatte Schuppe umhüllt die äussere der Knospe, u. eine andere die innere derselben; die erstere ist dunkelrothbraun, die letztere röthlich. Zweige schlank u. lang, an der Lichtseite rothbraun, sonst hellbraun. Blattpolster vorgewölbt. Blattnarbe schmal. Lent. fein, deutlich. Mark eng.

β.—Blattnarbe gross rundlich od. halbmondförmig.

*.—Baumgewächse.

Euscaphis japonica, *Pax.* Gonzui. *Taf. XI, Fig. 20.*

Am Ende der Triebe zwei Knospen; sie sind keilförmig, seitwärts gewölbt. Schuppen schwärzlich roth. Zweige ziemlich dick, auf der Lichtseite glänzend dunkelroth, sonst grünlich gelbroth. Lent. wenig. Mark weit, rund.

Acer japonicum, *Thunb.* Hauchiwa-kaede. *Taf. XI, Fig. 21.*

Endknospe zwei beisammenabstehend, eiförmig, zugespitzt, 3 od. 4 Schuppen sichtbar, schwärzlichroth gefärbt. Die stehenbleibende Korkschichte der Blattbasis bildet die Blattnarbe, sie ist gross u. unterseits eckig, am Rande behaart. Mark weit, eckig.

Acer Sieboldianum, *Max.* Kohauchiwa-kaede.

Knospen sind kürzer, u. Zweige schlanker als bei Acer japonicum.

**.—Strauchgewächse.

Hydrangea hortensis, *Smith.* **var. japonica,** *Maxim.* Gaku. *Taf. XI, Fig. 23.*

Endknospe grösser als Seitenknospe, spindelförmig 4 kantig, die äusseren zwei Schuppen leicht ablösbar. An der Seitenknospe 3 Schuppen sichtbar, dunkelrothbraun. Zweige glänzend hellbraun. Blattnarbe gross, abgerundet dreieckig od. halbmondförmig. Mark sehr weit.

Hydrangea Thunbergii, *Sieb.* Amacha.

Knospen u. Zweige sehr ähnlich wie bei der vorgenannten Art.

Hydrangea hortensia, *DC.* Ajisai. *Taf. XI, Fig. 24.*

Endknospe wesentlich grösser als Seitenknospe, eiförmig, zugespitzt. Die äusseren zwei Schuppen leicht ablösbar, die inneren unausgebildeten Blättchen bleiben schallen, glänzend gelblichgrün. Zweige dick, hell- od. graubraun. Blattnarbe gross, halbmondförmig od. etwas eckig. Mark sehr weit.

b.—Knospen u. Zweige behaart.

Ligustrum Ibota, *Sieb.* Ibotanoki. *Taf. XI, Fig. 25.*

Seitenknospen an der Zweige abgeplattet, keilförmig, dunkelgraufilzig behaart. Zweige schlank, filzig behaart, schmutzig bestäubt. Blattpolster vorspringend; Blattnarbe halbmondförmig. Lenticellen undeutlich. Mark eng.

VIII.—An den Seitenknospen mehr als 3 Schuppen sichtbar.

A.—Knospen u. Blattnarbe gross.

a.—Knospen kugelig.

Sambucus rasemosa, *L.* **var. Sieboldiana,** *Miq.* Niwatoko.

Knospen kugelig, gestielt, od. verkehrt eiförmig, roth bis violettgefärbt. Die zahlreichen Schuppen umgeben die Knospe ziemlich locker. Oefter stehen noch 1–3 Knospen unter der Hauptknospe. Zweige bogenförmig gekrümmt, grau, mit deutlichen Lenticellen versehen. Mark sehr weit, braun gefärbt.

b.—Knospen kantig.

Syringa vulgaris, *L.* Murasaki-hashidoi. *Taf. XI, Fig. 28.*

Knospen 4 kantig, zugespitzt, kurz. Schuppen carminroth, glänzend. Zweige dunkelgrau, schmutzig bestäubt. Blattnarbe ziemlich gross, dreieckig, od. halbmondförmig. Lent. ziemlich deutlich. Mark eng, eckig.

Syringa japonica, *Max.* Hashidoi. *Taf. XI, Fig. 27.*

Knospen 4 kantig, scharf gespitzt, Schuppen hellbraun. Zweige dunkelgrau, Blattnarbe gross, halbmondförmig. Blattpolster vorspringend. Lent. gross, deutlich. Mark eng, eckig.

B.—Knospen weniger gross, von der Schuppe sehr lose umhüllt od. nicht; Blattnarbe ziemlich gross.

a.—Knospen kegel- od. spindelförmig.

a.—Knospen unbehaart.

Enonymus oxyphyllus, *Miq.* Tsuribana. *Taf. XII, Fig. 1.*

Knospen spindelförmig schlank, sehr lang, dicht beschuppt, auf der Lichtseite dunkelröthlich, sonst dunkelgelblich grün. Zweige dünn auf der Lichtseite rothbraun, auf der Schattenseite grün, die älteren braun. Blattnarbe dreieckig od. halbmondförmig. Lent. sehr wenig. Mark eckig.

Forsythia suspensa, *Vahl.* Rengyō. *Taf. XII, Fig. 3.*

Blütenknospen spindelig, locker beschuppt. Zweige u. Schuppen gelblichgrau. Blattpolster vorspringend. Blatttnarbe halbmondförmig, in der Mitte mit einer hervortretenden Gefässbündelspur. Mark hohl.

Viburnum phlebotrichum, *Sieb. et Zucc.* Otokoyōzome.

Taf. XII, Fig. 2.

Endknospen (Blüten) kugelig, zugespitzt. Seitenknospen über der Blattnarbe aufrecht stehend, spindelig, etwas flach;

4–5 Schuppen sichtbar. Schuppen schwärzlich roth, glänzend, Zweige weisslichgrau. Lenticellen wenig. Mark rund.

β.—Knospen behaart.

Acer nikoense, *Maxim.* Megusurinoki. *Taf. XII, Fig. 4.*

Knospen spindelig, lang, an der Spitze der Langtrieben gehäuft, 4–5. Schuppen schwärzlichbraun, graubraunfilzig behaart. Blattnarbe schmal, umfasst die Knospe, am Rande mit langen Haaren. Zweige schwärzlichbraun schmutzig. Lenticellen zahlreich, deutlich. Mark weit.

b.—Knospen kantig.

α.—Knospen von eigentlichen schuppen umgeben.

Acer carpinifolium, *Sieb. et Zucc.* Chidorinoki. *Taf. XII, Fig. 5, 6.*

Am Ende der Triebe 2 od. 3 Knospen beisammenstehend, scharfkantig dunkelroth, an der Basis schwach behaart. Zweige röthlichbraun, auf der Schattenseite graubraun. Blattnarbe umfasst die Knospe. Lenticellen gross, sehr deutlich. Der Stamm grauweiss.

Evonymus alatus, *Fr. et Sav.* Nishikigi. *Taf. XII, Fig. 8.*

Drei Knospen an der Spitze der Triebe, kantig, zugespitzt. Schuppen dunkelrothbraun weisslich gefleckt. Zweige grün, auf der Lichtseite rothbraun, mit 2 od. 4 herablaufenden Korkleisten. Mark 4 kantig, die Kante der Lage der Korkleisten entsprechend.

Evonymus europæus, *L.* **var. Hamilitonianus,** *Max.* Mayumi. *Taf. XII, Fig. 9.*

Knospen ein wenig scharfkantig, etwas flach, von Schuppen lose umhüllt. Schuppen dunkelrothlichbraun, weisslich gerändert. Zweige grünlichrøth. Blattpolster vorspringend. Blattnarbe ziemlich gross, halbmondförmig. Mark rund. Das Holz hat gelbe Färbung.

Calycanthus præcox, *L.* Rōbai. *Taf. XII, Fig. 15.*

Knospen eiförmig etwas kantig. Schuppen braun. Zweige braun, weisslich bekleidet, so haben sie eine hellbraue Färbung glänzend. Blattnarbe ziemlich gross, herzförmig. Lent.

deutlich. Mark weit, 6 kantig. Im Winter kugelige Blütenknospen tragend.

Deutzia scabra, *Thunb.* Utsugi. *Taf. XII, Fig. 10.*

Knospen 4 scharfkantig, zugespitzt, etwas lang. Schuppen hellbraun, dunkler gerändert, graubraun mehlig. Zweige braun od. dunkelbraun. Die obere Peridermschichte rissig. Mark hohl.

Diervilla grandiflora, *Sieb. et Zucc.* Hakone-utsugi.

Taf. XII, Fig. 13, 14.

Endknospe grösser als Seitenknospen, die letzteren bogig gekrümmt, locker beschuppt. Schuppen graubraun; Zweige von derselben Farbe. Blattnarbe sehr gross. Lent. gross, deutlich. Mark sehr weit.

Diervilla japonica, *Sieb. et Zucc.* Tani-utsugi.

Taf. XII, Fig. 12.

Knospen locker beschuppt. Schuppen u. Zweige dunkelrothbraun, teilweise schwärzlich. Blattnarbe gross. Mark weit.

Ligustrum medium, *Fr. et Sav.* Ōba-ibotanoki.

Taf. XI, Fig. 26.

Knospen 4 kantig, zugespitzt, locker beschuppt. Schuppen dunkelcarminröthlich, am Rande hellbraun, von vertrocknetem Aussehen. Blattpolster sehr hoch vorspringend, Blattnarbe halbmondförmig. Lent. wenig vorhanden, aber deutlich. Mark rundlich od. schwach eckig.

Acer Ginnala, *Maxim.* Kara-kogi. *Taf. XII, Fig. 7.*

Endknospe etwas grösser als Seitenknospen, beide 4 kantig, kurz. Schuppen braun, weisslich bereift. Zweige schmal, Blattnarbe schmal, verkehrt V-förmig. Lent. deutlich. Mark rund.

β.—Knospen von pfriemenförmigen Schuppen umgeben.

Deutzia gracilis, *Sieb. et Zucc.* Hime-utsugi. *Taf. XII, Fig. 11.*

Knospen kugelig, flach, od. von der form einer gleichschenklichen Dreieckig, bogig gekrümmt. Schuppen u. Zweige grau, od. graubraun dunkler gefleckt. Blattnarbe schmal sichelförmig. Mark hohl.

c.—Knospen kugelig.

Catalpa Kæmpferi, *Sieb. et Zucc.* Kisasage. *Taf. XII, Fig. 17.*

Knospen zumeist quirlständig (3), kugelig, von dunkelbraunen Schuppen sehr locker umgeben, vom Aussehen geöffeneter Kiefernzapfen. Zweige dick graubraun, die älteren dunkler. Blattnarbe gross, rundlich, gewölbt. Lent. deutlich. Mark sehr weit von unregelmässiger Form.

Hydrangea paniculata, *Sieb.* Norinoki. *Taf. XI, Fig. 22.*

Endknospe grösser als Seitenknospen, kugelig, am Triebende ganz dicht sitzend, locker beschuppt, dunkel od. schwärzlichbraun. Die Seitenknospen kegelförmig, kurz onv der Triebe fast senkrecht abstehend. Zweige ziemlich dick, gerade pfeifenrohrartig, dunkelröthlich braun. Blattnarbe gross. Lent. deutlich. Mark sehr weit. Knospen oft quirlständig (3).

C.—Knospen an der Spitze der Triebe gross, an der Basis klein.

a.—Blattnarbe klein.

Acer pycnanthum, *C. Koch.* Hana-kaede. *Taf. XII, Fig. 19.*

Endknospe wesentlich grösser als Seitenknospen scharfkantig, zugespitzt. Seitenknospen etwas flach. Schuppen dunkelröthlich, am Rande wenig behaart. Die einjährigen Zweige, glänzend roth. Blattnarbe schmal. Lent. wenig, deutlich. Mark weit, rund.

b.—Blattnarbe ziemlich gross.

Acer purpurascens, *Fr. et Sav.* Kaji-kaede. *Taf. XII, Fig. 20.*

Knospen kantig, zugespitzt, Schuppen dunkelbraun, grauweiss, dicht filzig behaart. Zweige etwas dick, graubraun glänzend, fein rissig. Blattnarbe von nebenstehender Form . Lenticellen vorspringend. Mark rundlich, od. von unregelmässiger Form.

Acer pictum, *Thunb.* Itaya-kaede. *Taf. XII, Fig. 18.*

Endknospe eiförmig, etwas kantig, locker beschuppt. Seitenknospen an den Trieben abgeplattet, rückwärts gewölbt, käfergestaltig. Schuppen dunkelrothlich, glänzend. Junge Zweige grauweiss od. graubraun glänzend wie lackiert.

Lent. deutlich. Blattnarbe schmal, umfasst die Knospe. Die Rinde milchsaftig.

Acer pictum, *Thunb.* **var. ?**

Die Form u. Farbe der Knospe ähnlich wie bei der Acer pictum. Junge Zweige rothbraun, glänzend, rissig, die älteren schwärzlichbraun. Blattnarbe schmal. Lent. deutlich. Mark weit.

D.—Knospen klein.

a.—Schuppen gegenständig angeordnet.

α.—Zweige dünn.

Abelia serrata, *Sieb. et Zucc.* Kotsubane-utsugi.

Taf. XII, Fig. 21.

Knospen sehr klein, 2–4 mm. lang, eiförmig zugespitzt, etwas kantig. Schuppen braun od. rothbraun, am Rande ein wenig behaart. Zweige auf der Lichtseite dunkelgrau, auf der Schattenseite hell- od. dunkelbraun, glänzend, ältere grau. Lent. undeutlich. Mark weit.

β.—Zweige auffallend dick.

Paulownia tomentosa, *Baill.* Kiri. *Taf. XII, Fig. 16.*

Knospen klein, dicht sitzend, Schuppen dunkelgraubraun. Zweige dick, dunkelgrünlichgrau, mit hellen Flecken u. zahlreichen rauhen Lenticellen versehen. Blattnarbe gross, rundlich. Mark gefächert.

b.—Schuppen spiralig angeordnet.

IX.—Zweige kletternd (Schlinggewächse).

1.—Knospen sind von einer od. zwei Schuppen umgeben.

Pædelia fœlida, *L.* Hekuso-kazura. *Taf. XII, Fig. 22.*

Knospen klein, kegelförmig, kurz. Schuppen u. Zweige hellbraun ein wenig behaart. Blattnarbe etwas gross, halbelliptisch gewölbt. Mark bandförmig. Die Rinde hat einen unangenehmen Geruch. Im Winter bleiben die glänzend hellbraune, kleinen kugeligen Früchte.

2.—Knospen vou mehreren Schuppen umgeben.

A.—Zweige mit Ranken.

Clematis japonica, *Thunb.* Tsurigane-kazura. *Taf. XII, Fig. 23.*

Knospen kugelig an der Triebe senkrecht stehend. Schuppen filzig behaart, grauweiss, glänzend, aber die äussersten zwei Schuppen sind derb, schwarzbraun. *Z*weige dunkelbraun, glatt; die jüngere ein wenig behaart. Lent. undeutlich. Mark eng.

B.—*Z*weige ohne Ranken.

Schizophragma hydrangeoides, *Sieb. et Zucc.* Iwagarami.
Taf. XII, Fig. 24.

Knospen cylindrisch, locker beschuppt, braun. *Z*weige ziemlich dick; die jüngeren hellbraun behaart; die älteren grau. Blattnarbe gross, dreieckig, od. halbmondförmig. Mark gross etwas eckig.

Hydrangea petiolaris, *Sieb. et Zucc.* **var. cordifolia,** *Max.*
Gotōzuru. *Taf. XII, Fig. 25.*

Endknospen grösser als Seitenknospen, lang gestreckt, von Pyramidenform, locker beschuppt, hellgelb od. hellroth. *Z*weige braun, lang, mit zahlreichen Luftwurzeln versehen. Blattnarbe schmal. Lent. undeutlich. Mark weit, grünlich gefärbt.

TABELLE IV.

Zweige "quilständig."

I.—Knospen sind von unausgebildeten Blättchen umgeben.

Clethra barbinervis, *Sieb. et Zucc.* Ryōbu. *Taf. XIII, Fig. 1, 2.*

Drei unausgebildete Blättchen umgeben die Knospe, dreikantig, die Spitze gekrümmt, weissbraun dichtfilzig behaart. Zweige sparrig, gerade, lang, hellbraun, die jungeren Theile grauweiss, mehlartig. Die zahlreichen dreieckigen Blattnarben in der Nähe der Knospe zusammenstossend. Mark sehr weit, rundlich.

II.—Endknospe sehr gross, einjährige Zweige auffallend dick.

Sterculia platanifolia, *L.* Aogiri. *Taf. XIII, Fig. 4.*

Endknospen viel grösser als Seitenknospen, kugelig, dunkelbraun filzig behaart. Zweige dick, grün, teilweise schwärzlich. Blattnarb gross. Lent. deutlich. Mark rund.

Idesia polycarpa, *Max.* Iigiri. *Taf. XIII, Fig. 3.*

Zahlreiche, saftige Schuppen umgeben die Endknospe, sie sind dunkelrothbraun, kahl, harzig. Zweige dunkelrothbraun, die ältere grau. Blattnarbe rundlich. Lenticellen deutlich. Mark weit.

Aleurites cordat, *DC.* Abura-giri. *Taf. XIII, Fig. 5.*

Endknospe kugelig, locker beschuppt, dunkelröthlich. Zweige dunkelroth grünlich. Blattnarbe gross, braun gefärbt. Lent. deutlich, lang. Mark weit, rundlich.

III.—Knospen sitzend, von mehreren Schuppen umgeben, an der Langtrieben einzeln od. gehäuft.

A.—An der Langtriebe einzeln.

a.—Knospen kugelig- od. eiförmig.

Cornus macrophylla, *Wall.* Mizuki. *Taf. XIII, Fig. 6, 7.*

Knospen eiförmig, lang, locker beschuppt, glänzend dunkel-

rothbraun, kahl. Zweige sparrig, lang, vogelfussförmig, dunkelroth glänzend. Blattnarbe halbkreisförmig. Mark rundlich.

Andromeda cernua, *Miq.* Yōraku-tsutsuji.

Taf. XIII, Fig. 8, 9.

Knospen eiförmig. Die äusseren Knospenschuppen leicht ablösbar, braun, die inneren roth gefärbt. Zweige dünn, gerade, die ein-jährigen braun, die älteren graubraun. Blattnarbe klein. Mark weit.

b.—Knospen spindelig.

a.—Schuppen behaart.

Rhododendron dilatatum, *Miq.* Mitsuba-tsutsuji.

Taf. XIII, Fig. 10, 11.

Knospen spindelig, die Spitze etwas gekrümmt. Schuppen hellbraun behaart. Zweige gerade, die jüngeren hellbraun, die älteren dunkelgrau. Blattnarbe halbmondförmig. Mark rund, weit.

β.—Schuppen unbehaart.

Rhodopendron sinenses, *Sw.* Kirengetsutsuji.

Taf. XIII, Fig. 12.

Knospen sehr gross, spindelig, kurz. Schuppen rothbraun, teilweise schwärzlich, am Rande grauweiss, wenig behaart. Junge Zweige hellbraun glatt, ältere grau. Blattnarbe fusssohlenförmig. Mark eng, von unregelmässiger Form.

Enkyanthus japonicus, *Hook.* Dōdan. *Taf. XIII, Fig. 13, 14.*

Knospen spindelig, kurz. Schuppen spiralig angeordnet, carminröthlich, sehr schön. Zweige dünn, gerade, die jüngeren rothbraun, od. hellbraun, die älteren grau od. graubraun. Blattnarbe dreieckig.

B.—An der Langtrieben gehäuft.

Rhododendron Schlippenbachii, *Max.* Kurofune-tsutsuji.

Taf. XIII, Fig. 15.

Knospen gleich gross, od. seitwärts der grossen Knospe zahlreiche kleine flache Knospen zusammensitzend, hellbraun dichtfilzig behaart. Zweige ziemlich dick, gerade, lang, graubraun, sehr rauh. Blattnarbe gross. Mark von unregelmässiger Form.

ÜBERSICHT UND REGISTER.

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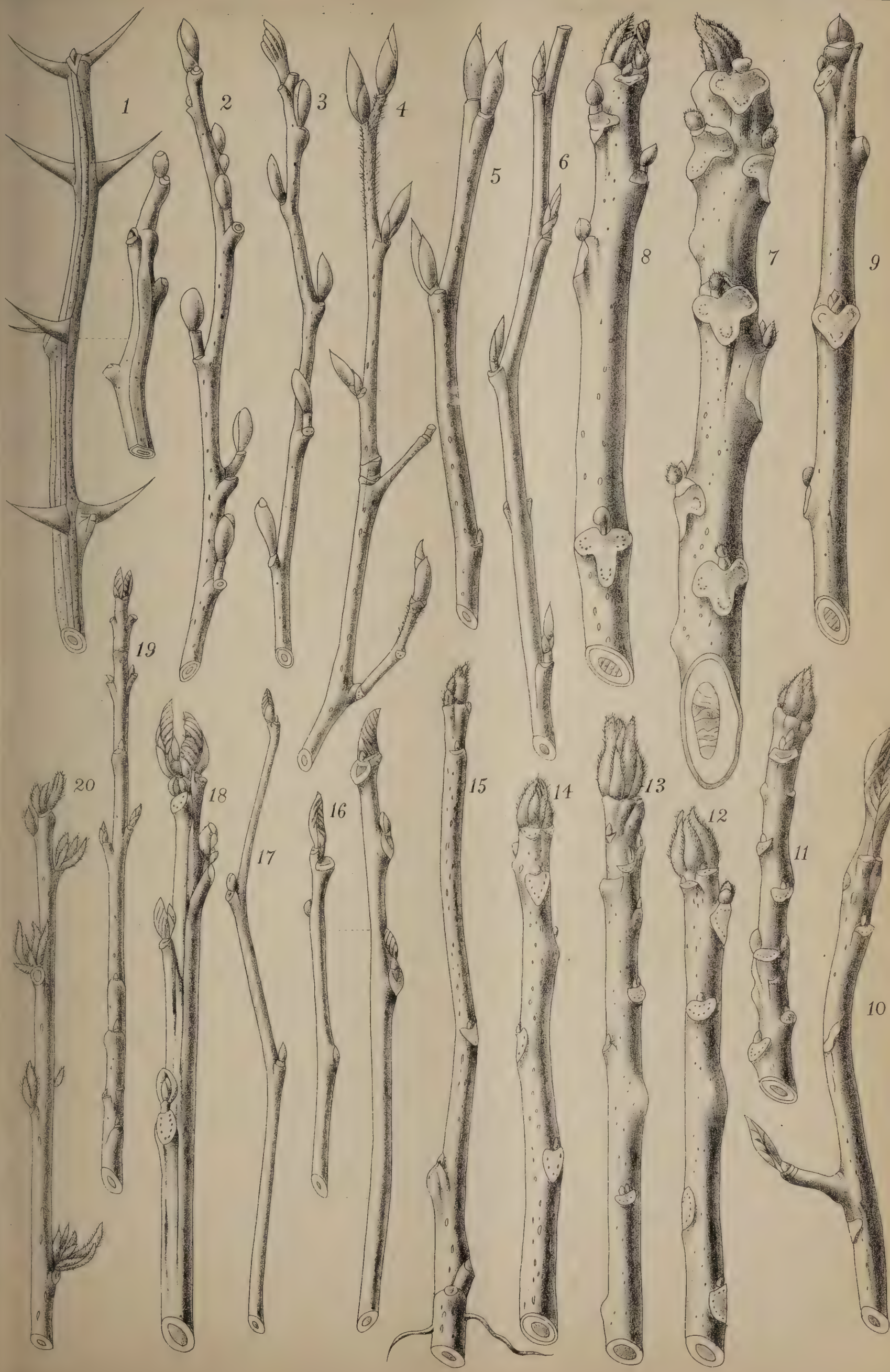

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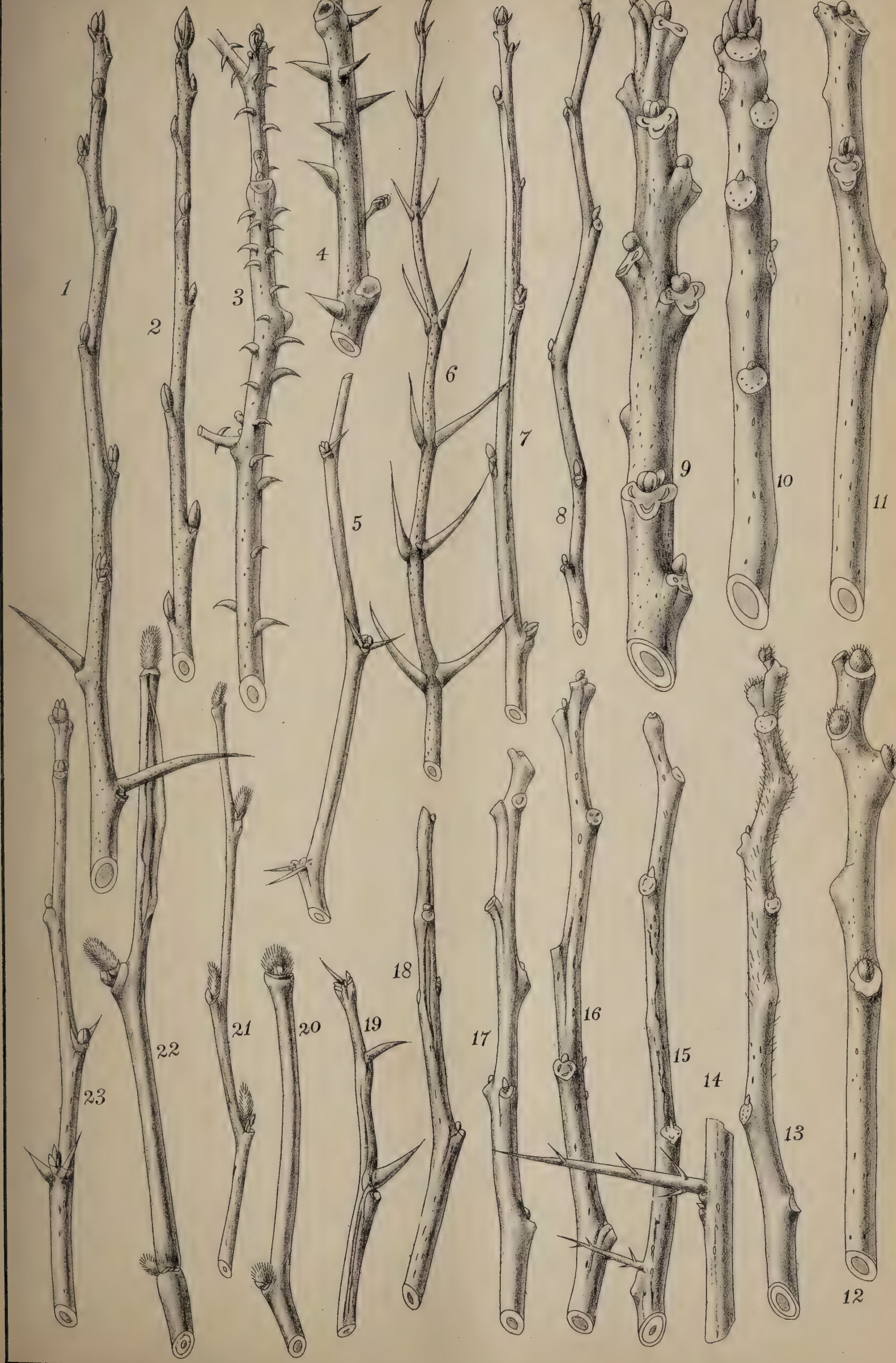

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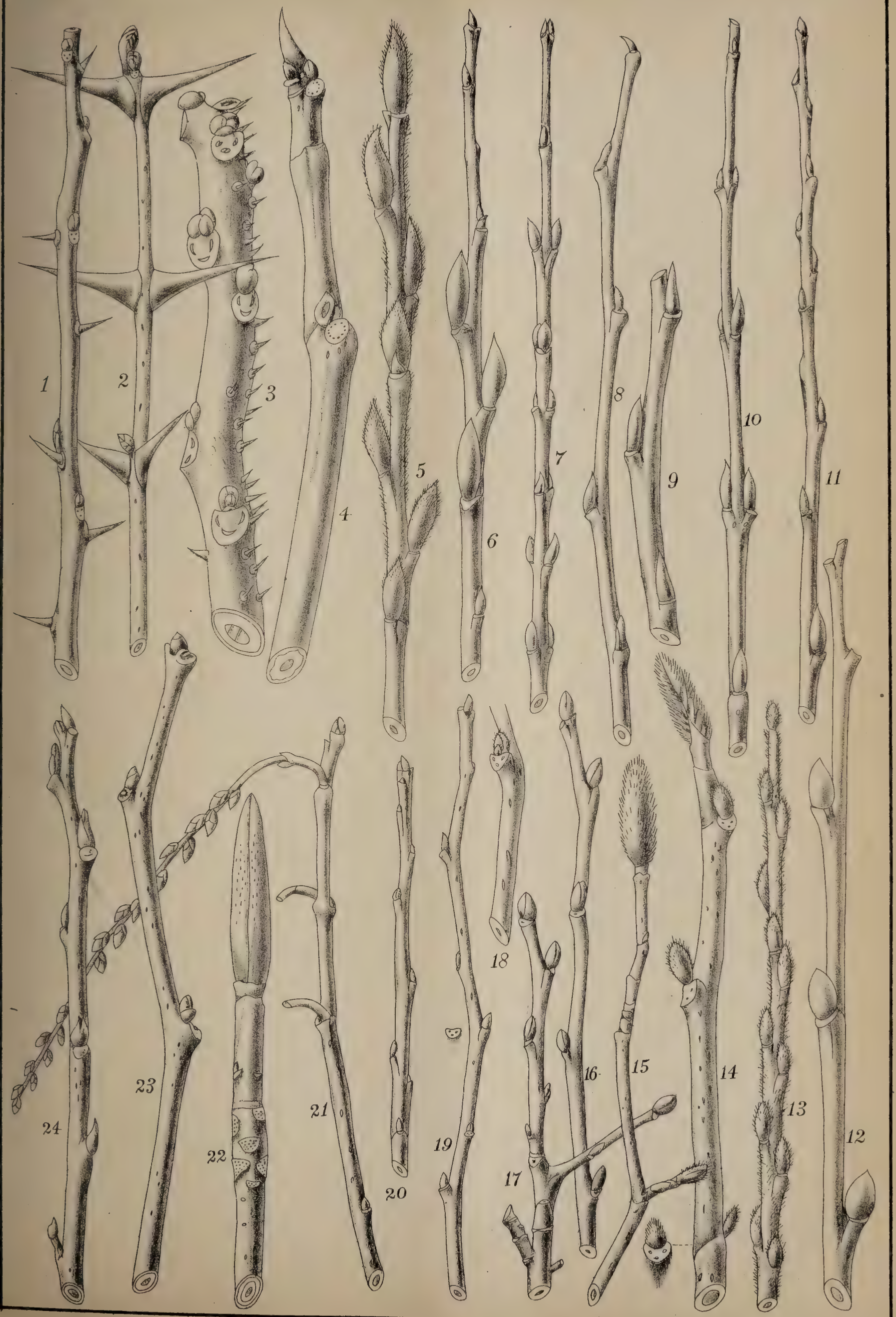

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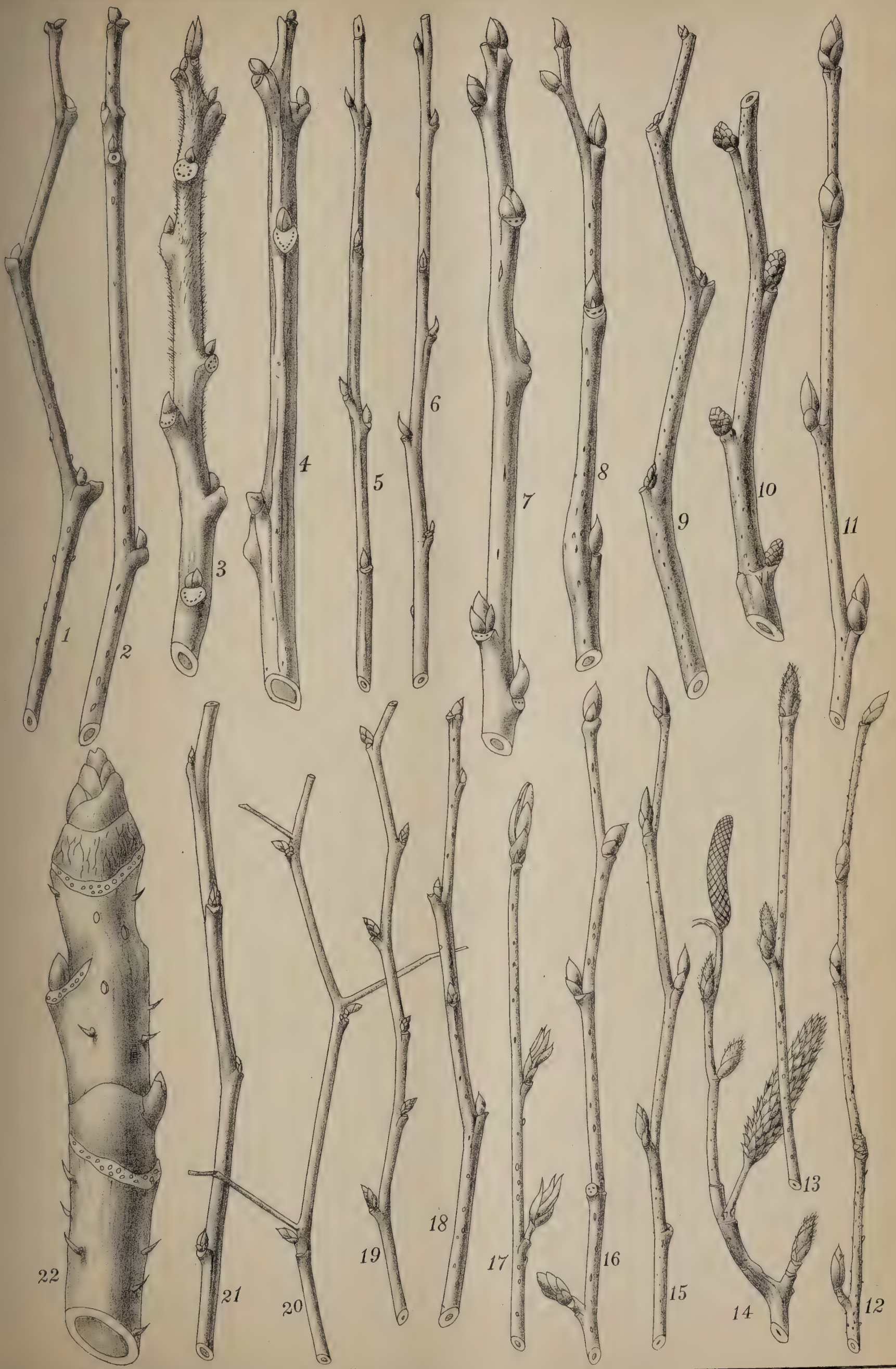

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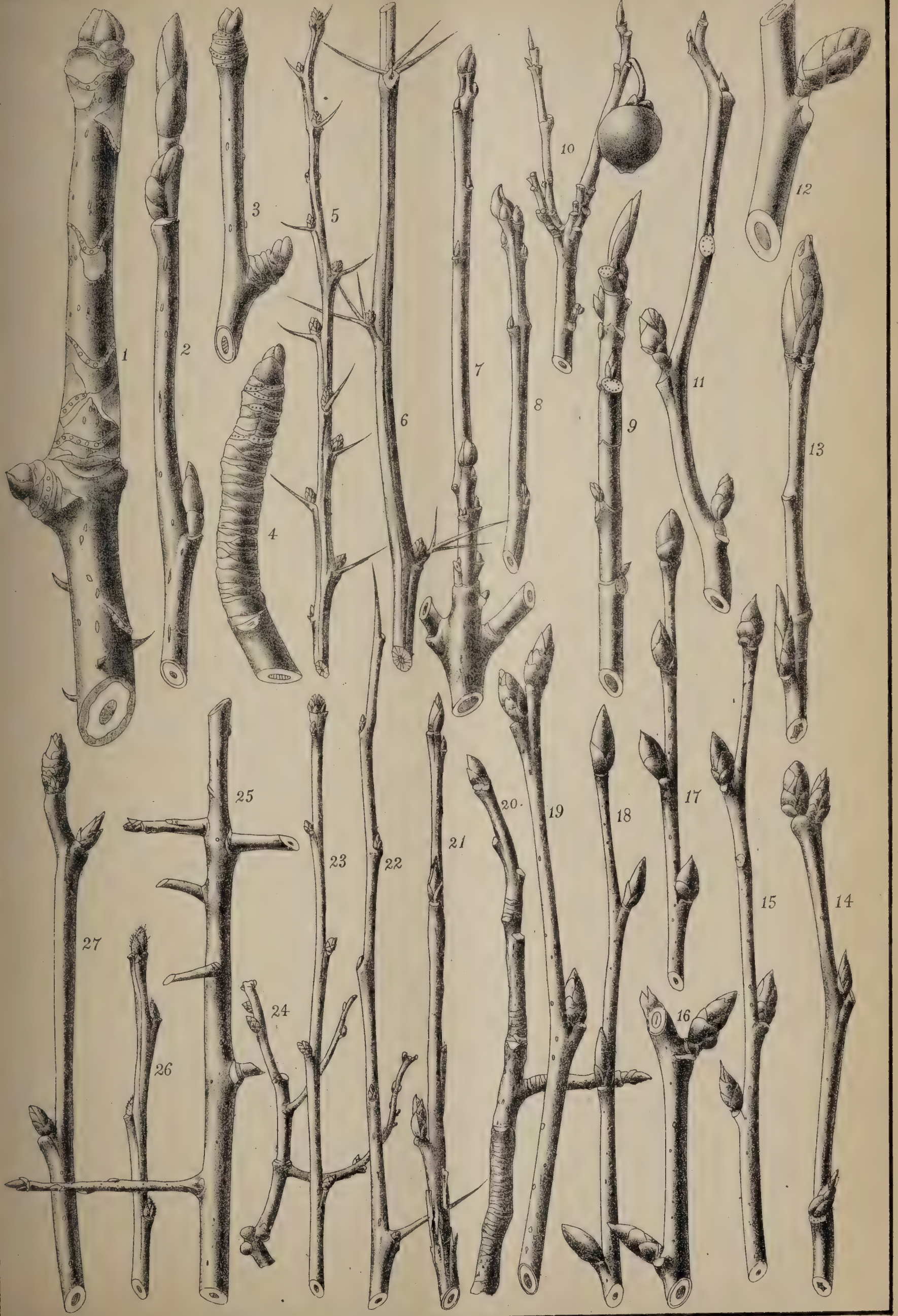

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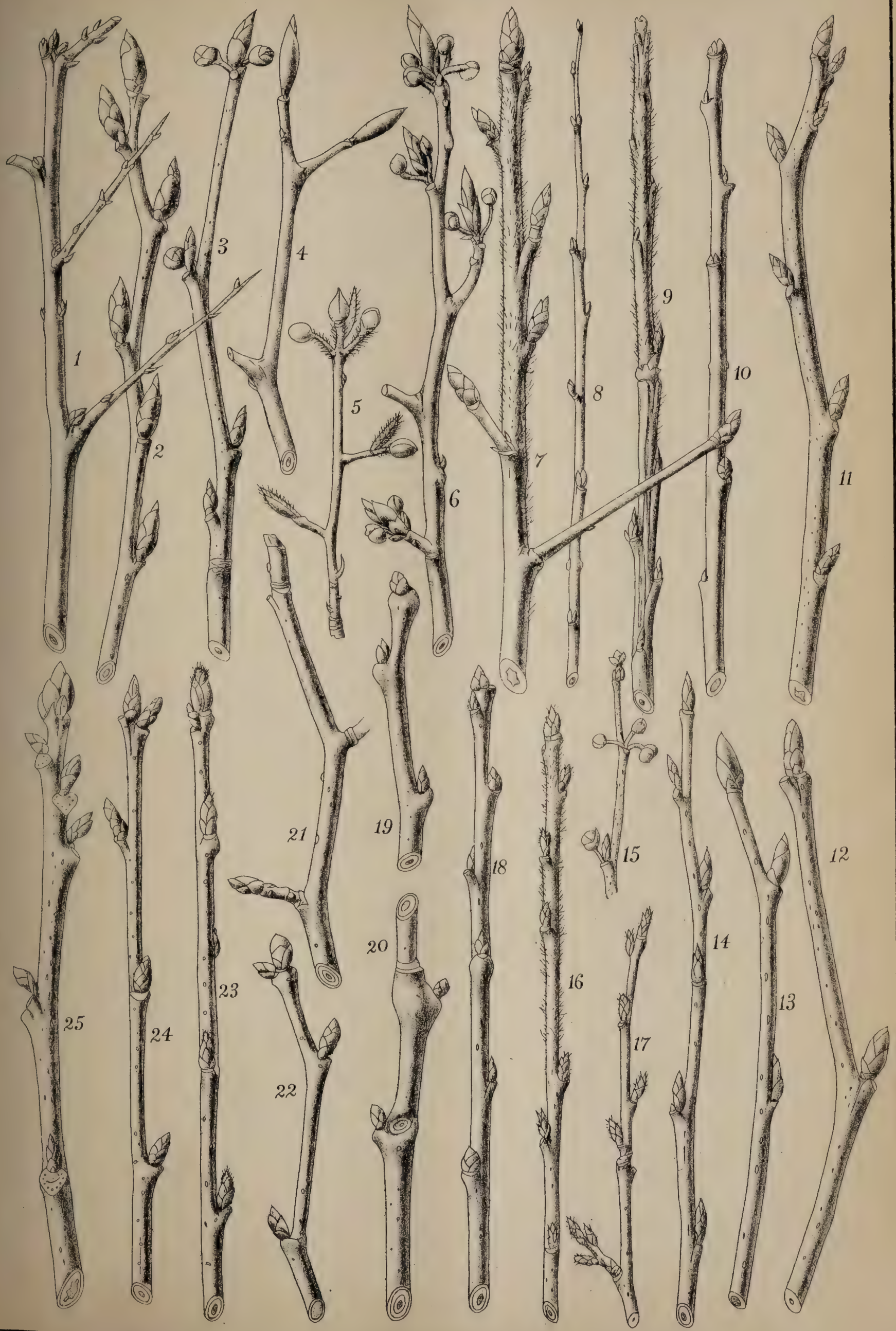

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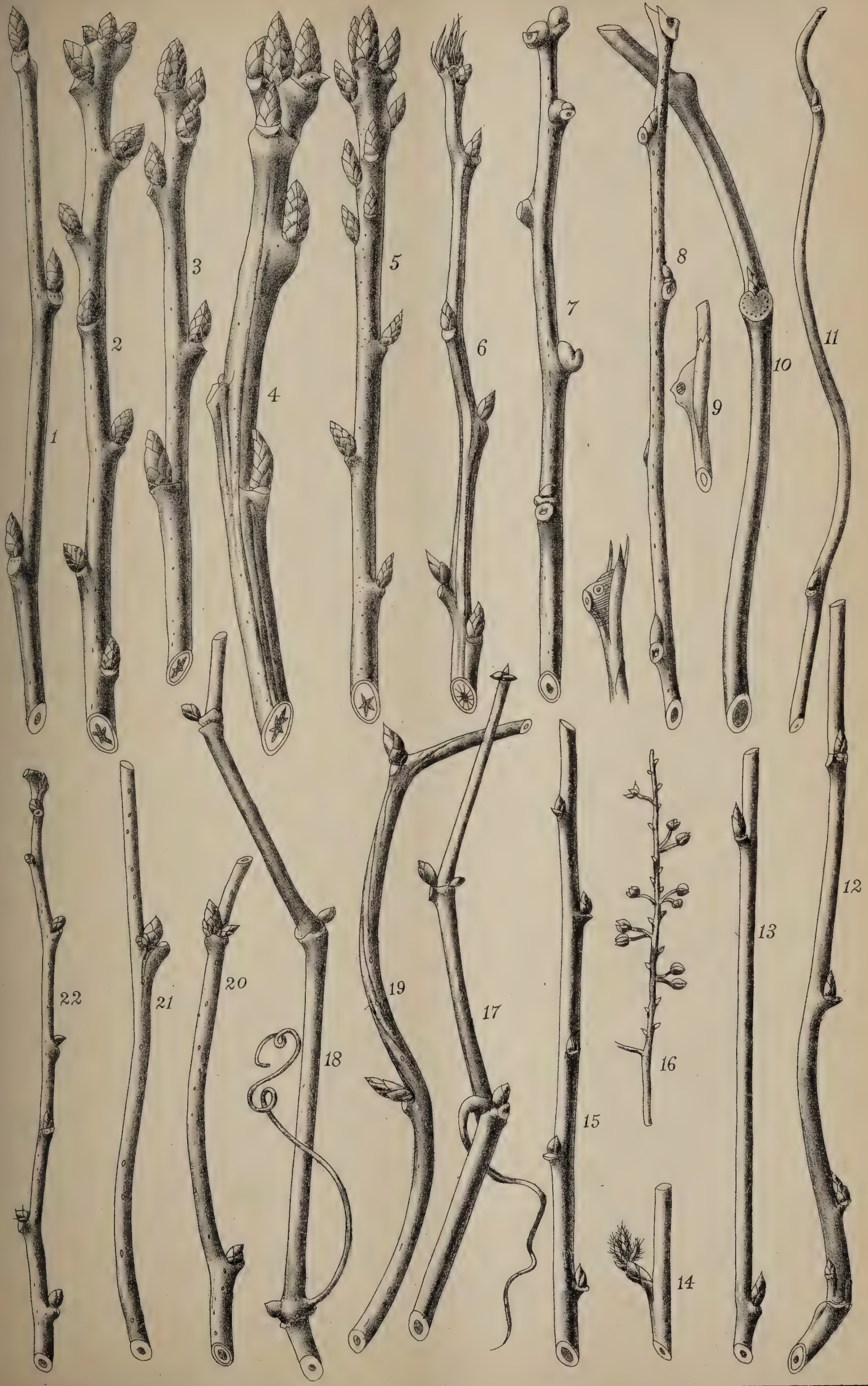

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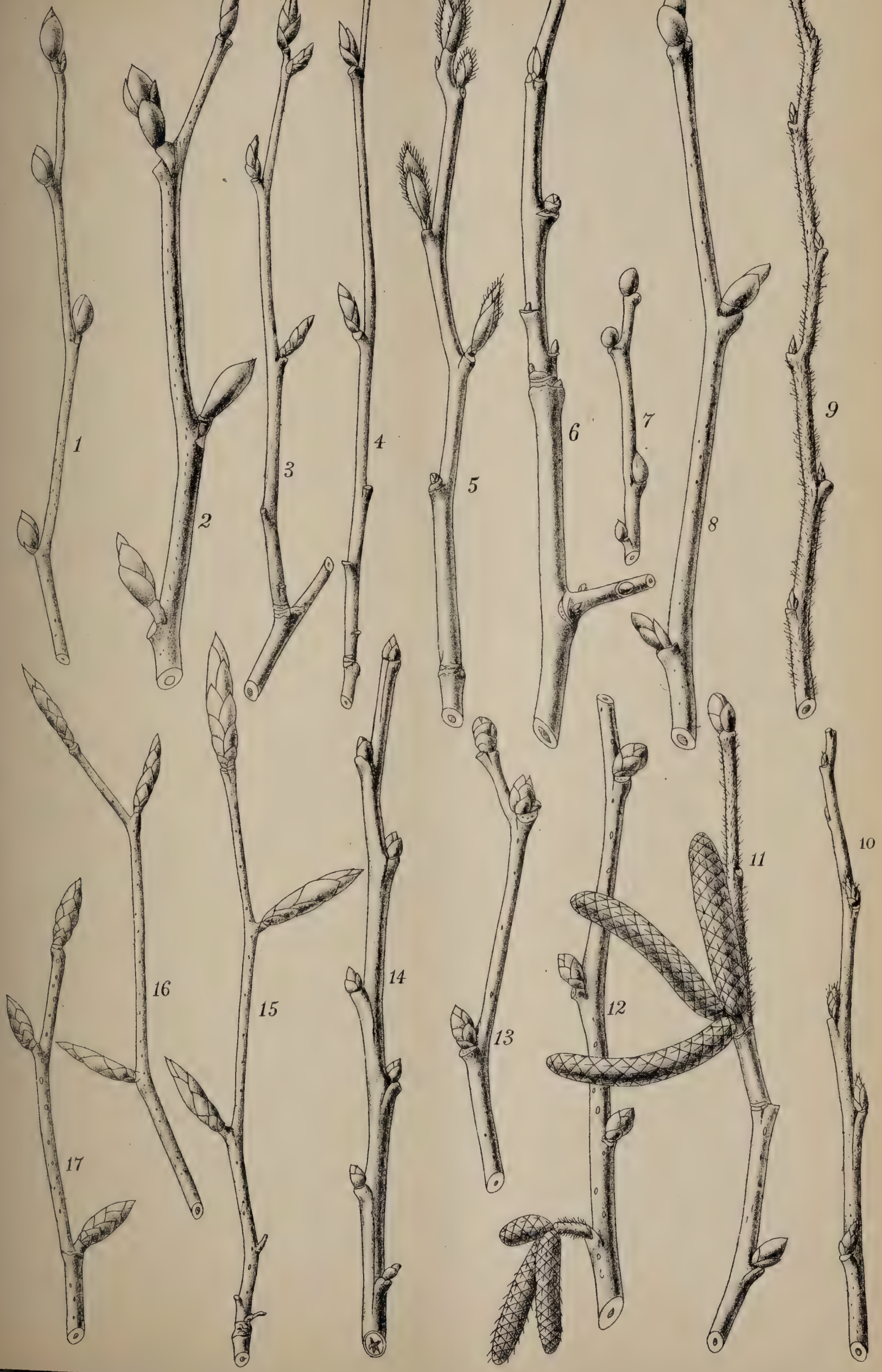

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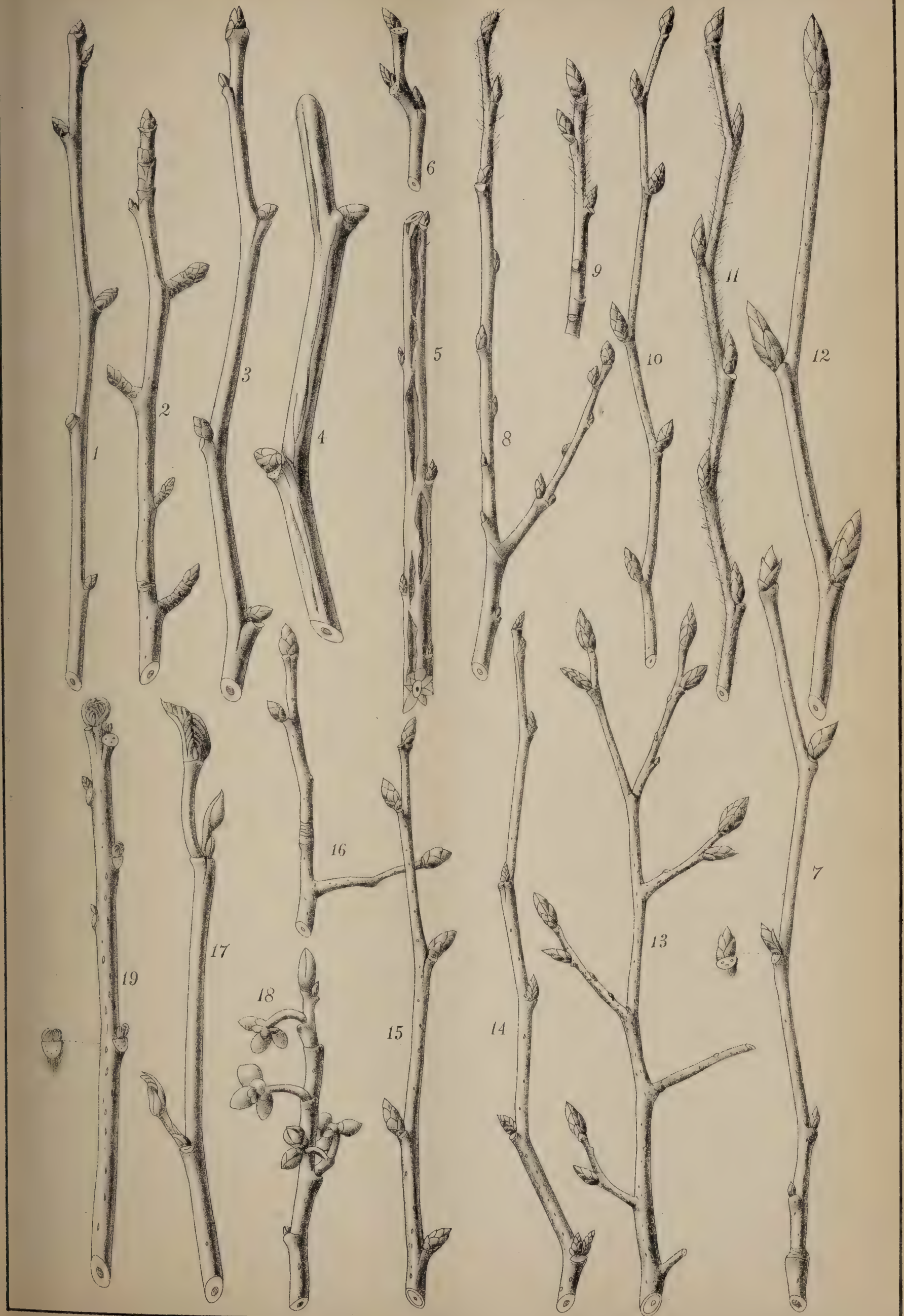

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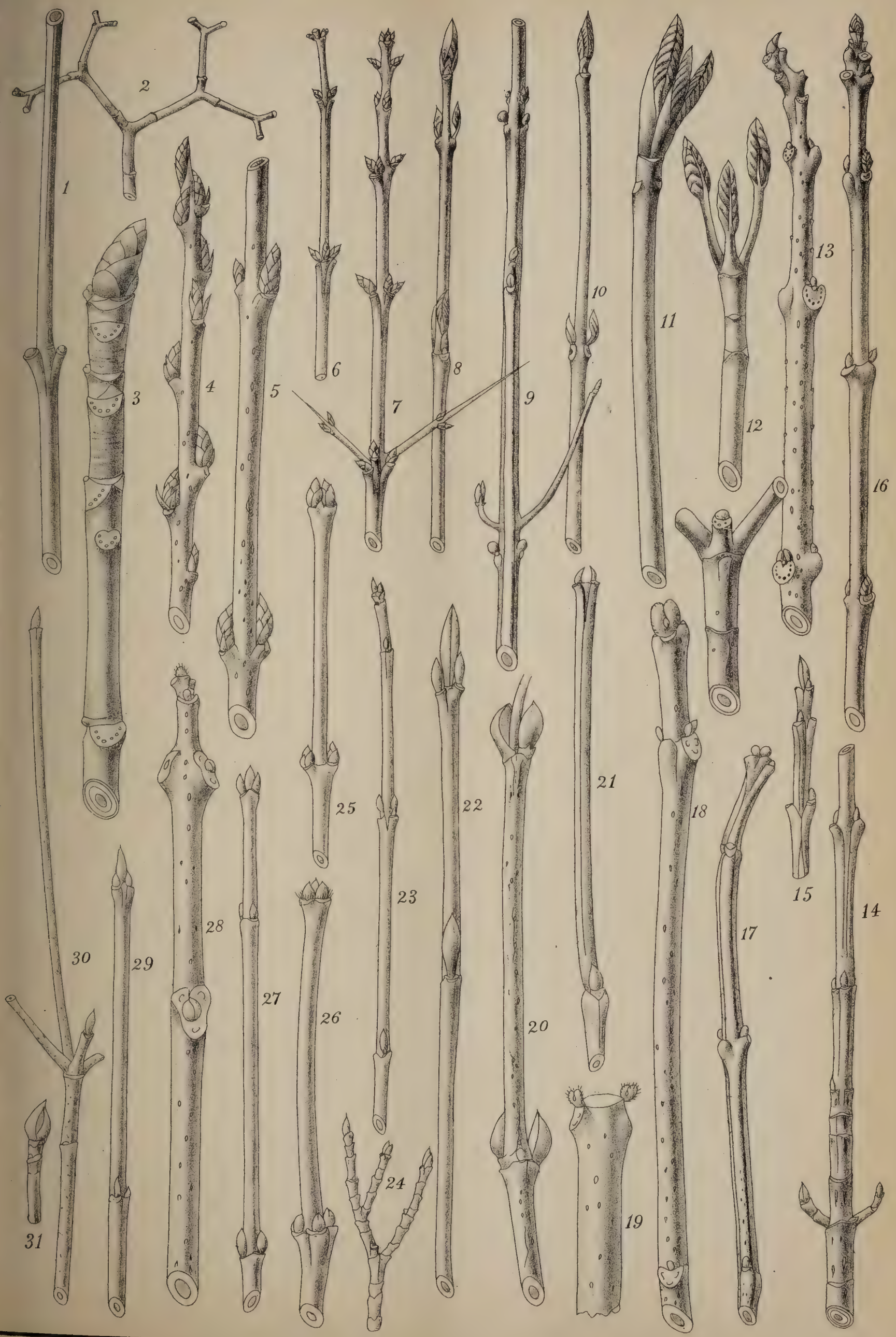

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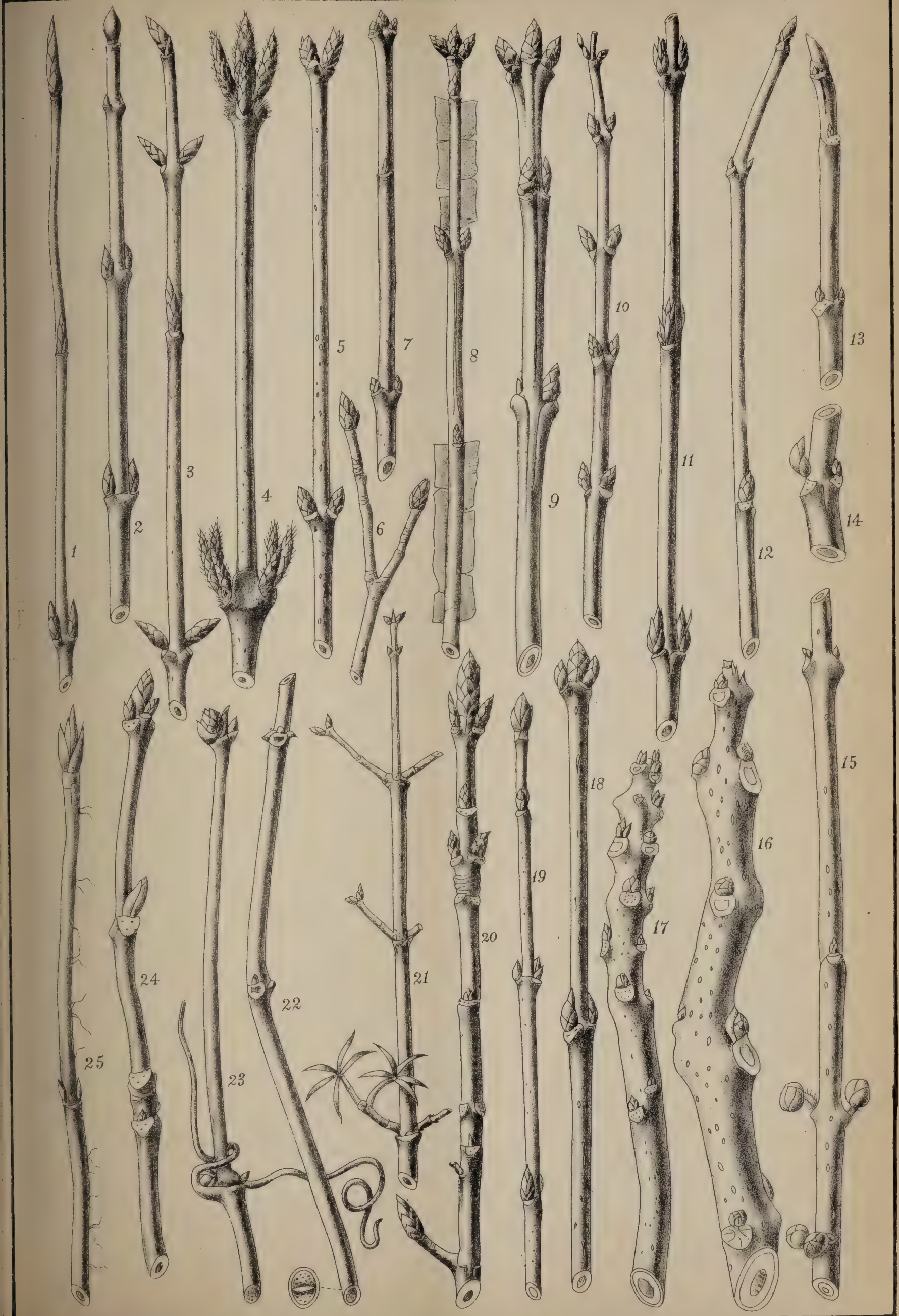

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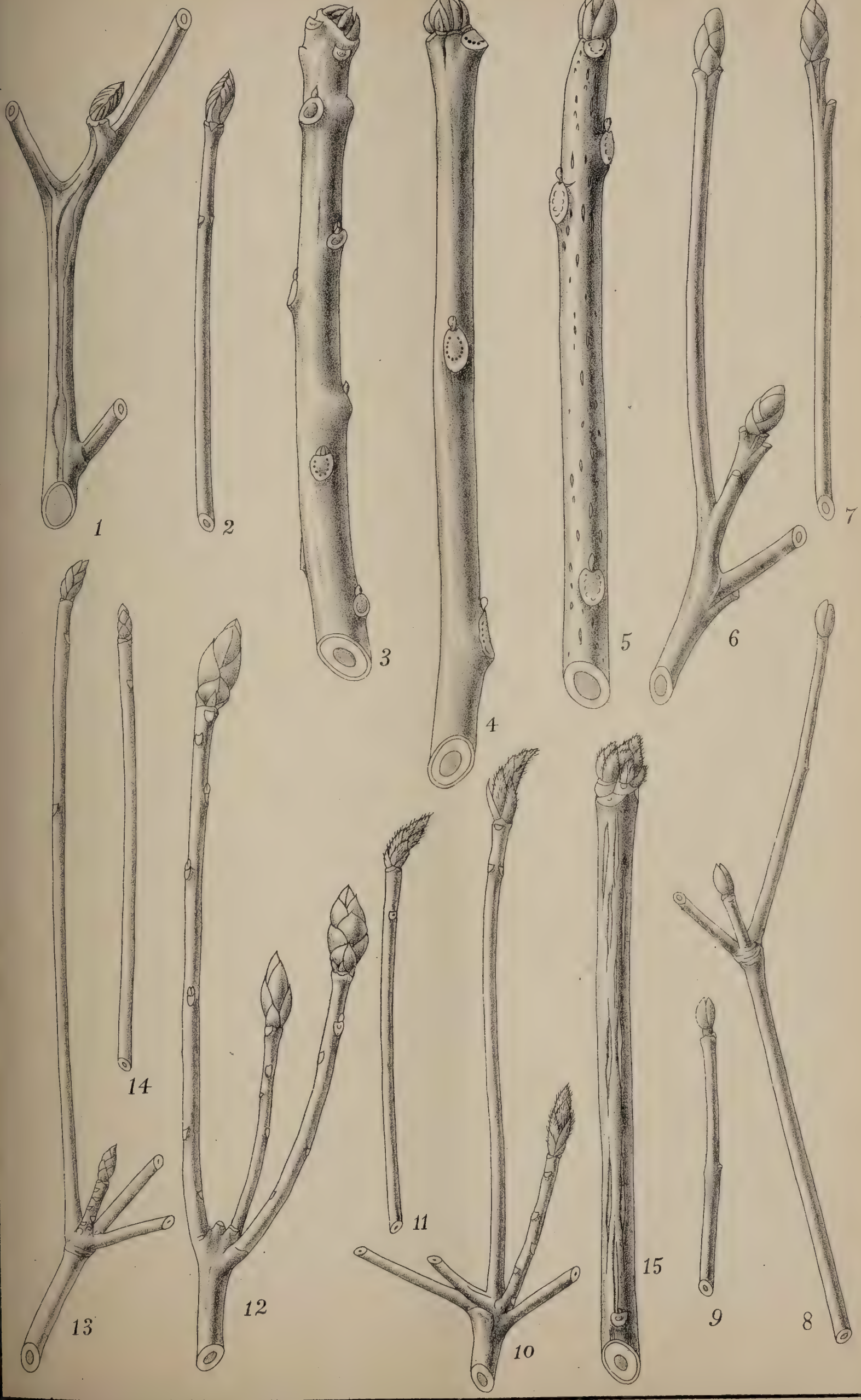

H. SHIRASAWA DEL.

Untersuchungen ueber das Klemmen der technisch wichtigsten Japanischen Holzarten.

VON

F. Koide, *Ringakushi.*

I. Einleitung.

Dass die genaue Kenntniss der technischen Eigenschaften der Hölzer so gut für den Forstmann, als für den holzverbrauchenden Techniker von der grössten Wichtigkeit ist, unterliegt keinem Zweifel. Indessen kommen Forstleute und Holzconsumenten selten in unmittelbare Berührung, was zur Folge hat, dass die fachlichgebildeten Forstleute oft nicht zu beurtheilen wissen, welche Eigenschaften das von ihnen gelieferte Holz besitzt. Es ist dies mit der Hauptgrund, warum die Forstbenutzungslehre noch so wenig Fortschritt gemacht hat.

Besonders in Japan, wo das Holz eine viel ausgedehntere und vielseitigere Verwendung findet, als in anderen Ländern, darf diese Kenntniss für den Forstmann in dem Grade, wie für den holzverbrauchenden Techniker als unentbehrlich bezeichnet werden. Es liegt daher uns japanischen Forstleuten, ob uns mehr mit der Ausbildung der Forstbenutzungslehre zu beschäftigen, als es von den europaeischen Fachgenossen bisher geschehen ist.

Wenn man im Allgemeinen die Eigenschaften der Hölzer betrachtet, welche auf der Zusammensetzung und mittelbar auf den äusseren Lebensumständen des Baumes beruhen, so kann man folgende drei Gruppen unterscheiden.

1. Eigenschaften nach der äusseren Erscheinung, welche durch den Gesichts- Geruchs- und Tastsinn wahrnehmbar sind.
2. Eigenschaften, welche den materiellen Zustand darstellen.

3. Eigenschaften nach dem Verhalten gegen von aussen einwirkende Kräfte.

Da von diesen Eigenschaften besonders diejenigen, welche in die zweite Gruppe fallen, und von diesen wieder das, wie ich glaube, zuerst von Nördlinger genauer untersuchte Klemmen, und Schwinden von hoher Wichtigkeit für die Bearbeitung des Holzes für Gewerbe sind, so sollen im Folgenden diese beiden Eigenschaften, wenn auch einiger der technisch wichtigsten japanischen Hölzer, näher untersucht werden.

II. Untersuchungsmaterialien.

Wenn man von einem frischgefällten Stamme eine Scheibe abschneidet, und an derselben in radialer Richtung vom Umfang gegen dem Mittelpunkt sägt, so nähern sich die Sägschnittsflächen in Folge der Spannungskraft des Holzkörpers.

Diese Erscheinung nennt man bekanntlich das Klemmen des Holzes und die Untersuchung dieser Erscheinung ist von besonderem Interesse, weil sie einen sehr grossen Einfluss aüssert

1. Auf die Schwindungsgrösse,
2. Auf die Sägearbeit der Holzhauer und endlich,
3. Auf den Ueberwallungsprocess der Spiegelrisse im lebenden Baume.

Den Grundstock meines Untersuchungsmateriales bilden die in der Gegend von Chichibu und Nikko gefällten Bäume.

Das Gebiet, in welchem die Nadelhölzer Larix leptolepis, Pinus densiflora, Abies Umbellata, Cryptomeria japonica, und Chamaecyparis obtusa, die winterkahlen Laubhölzer, Betula alba var, vulgaris, Magnolia hypoleuca, Prunus cerasoides, Zelkowa keaki und Juglans Sieboldiana gefällt wurden, ist derjenige Theil des Mitsuminegebirges, welcher Aza Isedaira genannt wird und einen Theil des Chichibureviers bildet. Die Fällungszeit war Anfang April. Die fünf Stämme von Tsuga Sieboldii, Betula ulmifolia, Acer Palmatum, Fagus japonica und Halesia corymbosum wuchsen

in der Nähe von Nikko und zwar in der Privatwaldungen Aza Umakayeshi und wurden am Anfang Mai gefällt.

Die vorgenannten Untersuchungsmaterialien dienten nun in erster Linie zur Feststellung der Grösse des Klemmens bei den verschiedenen Holzarten und ferner dazu, zu ermitteln, welchen Einfluss auf die Grösse des Klemmens die Rinde des Baumes, die Dicke der Scheibe, die Länge des Sägschnitts und der eigentliche Splinttheil &c., ausüben und endlich zu dem Versuche, den Grad des Klemmens als eine Function des Abstandes vom Mittelpunkt der Scheibe darzustellen.

Das Untersuchungsmaterial bestand aus:

Larix leptolepis (*Karamatsu*).

Auf einem Berghange mit einer Neigung von ca. 25° und der Exposition nach SW wurde ein 50-jähriger Baum gefällt, welcher hier bei genügendem Schlusse erwachsen war. Seine ganze Höhe betrug 23,4 m., die Länge des astfreien Schaftes 15 m. und der durchschnittliche Durchmesser 28,5 cm. in Brusthöhe. Der Stamm war vollhölzig und der Jahrringbau schön concentrisch.

Pinus densiflora (*Akamatsu*).

Lage, Neigung, Exposition und Schlussverhältnisse waren ganz ähnlich wie bei Larix leptolepis.

In einem gemischten Bestande von Sugi und Hinoki mit einzelnen Akamatsu liess ich eine der letzteren fällen. Die ganze Höhe des 82jährigen Stammes betrug 20,5 m. die Länge des astfreien Schaftes 11,5 m. und der durchschnittliche Durchmesser in Brusthöhe 33,5 cm. Der Stamm war vollhölzig und der Jahrringbau ziemlich concentrisch.

Abies umbellata (*Urashiromomi*).

In derselben Lage wie Akamatsu wurde ein 82jähriges Exemplar gefällt.

Die ganze Höhe des Baumes betrug 18,4 m, die Länge des astfreien Schaftes 7,2 m. und der durchschnittliche Durch-

messer 31,5 cm. in Brusthöhe. Der Stamm war sehr vollhölzig und der Jahrringbau schön concentrisch.

Cryptomeria japonica (*Sugi*).

Auf einem Hange mit einer Neigung von ca. 30° und der Exposition nach SO wurde ein Probestamm von 75 jährigem Alter, einer Gesammthöhe von 21 m einer Länge des astfreien Schaftes von 12,5 m., einen durchschnittlichen Durchmesser von 25,3 cm in Brusthöhe ausgewählt. Der Stamm war in einem mit Hinoki und Sawara gleichmässig gemischter Bestande im dichten Schlusse erwachsen. Der Stamm war auch vollhölzig und der Jahrringbau schön concentrisch.

Chamaecyparis obtusa (*Hinoki*).

Ein unter denselben Verhältnissen mit der Sugi erwachsener Baum wurde gefällt. Das Alter war 88 Jahre, der Stamm vollhölzig und der Jahrringbau concentrisch.

Die ganze Länge des Stammes betrug 24 m., die Länge bis zum Kronenansatz 13,5 m. und der durchschnittliche Durchmesser in Brusthöhe 23 cm.

Betula alba var. vulgaris (*Shirakaba*).

Ein Baum von 33 jährigem Alter wurde auf einem Hange einer Neigung von ca. 30° mit einer nördlichen Exposition gefällt, wo er im genügenden Schlusse erwachsen war. Die ganze Höhe des Baumes betrug 18 m, die Länge des astfreien Schaftes 7 m. und der durchschnittliche Durchmesser in Brusthöhe 23 cm. Der Stamm war sehr astreich und der Jahrringbau etwas excentrisch.

Magnolia hypoleuca (*Hōnoki*).

Aus einem mit verschiedenen anderen winterkahlen Laubhölzern gemischten und sehr dicht geschlossenen Bestande, auf dem Hange einer Neigung von ca. 30° und der Exposition OS. Das Alter war 65 Jahre, die ganze Höhe des Baumes betrug 17,5 m, die Länge des astfreien Schaftes 8,5 m. und der durchschnittliche Durchmesser in Brusthöhe 32 cm, Der

Stamm war sehr astreich und abhölzig und der Jahrringbau dabei sehr excentrisch.

Prunus cerasoides (*Mejiro-zakura*).

Ein Probestamm von 52jährigem Alter wurde in einem wie bei Hōnoki gemischten, aber etwas lichten Bestand ausgesucht.

Die Neigung des Standortes betrug ca. 10_0 und die Exposition war Süd. Der Stamm besass eine Gesammthöhe von 16,5 m, eine Länge des astfreien Schaftes von 6,5 m. und einen durchschnittlichen durchmesser in Brusthöhe von 22,5 cm. Der Stamm war sehr astreich und der Jahrringbau daher sehr excentrisch.

Zelkowa Keaki (*Keaki*).

Auf einem Berghange mit einer Neigung von ca. 30° und einer westlichen Exposition fand ich eine 82 jährige Keaki, welche in gemischtem Bestande von Sugi und Hinoki im ziemlich dichten Schlusse erwachsen war.

Die ganze Höhe des Stammes war 20,6 m, die Schaftslänge bis zum Kronenansatz 8,1 m, und der durchschnittliche Durchmesser in Brusthöhe 35 cm. Der Stamm war sehr astreich, aber der Jahrringbau ziemlich concentrisch.

Juglans Sieboldiana (*Oni-gurumi*).

Auf einem Hange mit einer Neigung von ca. 50° und der Exposition SW wurde, unter ähnlichen Bestand-verhältnissen wie bei Mejiro-zakura angegeben wurde, eine 70 jährige Oni-gurumi mit einer gangen Höhe von 13,5 m, einer Länge des astfreien Schaftes von 5,7 m und einem durchschnittlichen Durchmesser in Brusthöhe von 28,5 cm gefällt. Der Stamm war etwas kränklich, sehr astreich und abhölzig und der Jahrringbau sehr excentrisch.

Tsuga Sieboldii (*Tsuga*).

In einem Bestande mit einer Neigung von Ca. 20° und einer nordwestlichen Exposition wurde ein Baum von 80 jähringem Alter, einer Gesammthöhe von 16 m, einer Länge

des astlosen Schaftes von 4 m und einem durchschnittlichen Durchmesser in Brusthöhe von 25,4 cm. gefunden.

Der Baum war in gemischtem Bestand von verschiedenen anderen winterkahlen Laubhölzern in Einzelmischung. Aus dem Verhältnisse des Stärkezuwachses schien es, dass er von zwanzigstem Jahre bis etwa vierzigstem durch andere Bäume stark untergedruckt wurde und er später in Folge günstigerer Schlussverhältnisse wieder kräftiger gewachsen ist. Der Stamm war sehr astreich und abhölzig, aber der Jahrringbau ziemlich concentrisch.

Betula ulmifolia (*Yoguso-minebari*).

In einem mit verschiedenen Laubhölzern gemischten und beinahe genügend geschlossenen Bestande auf einem Hange von einer Neigung von ca. 20° und bei südöstlicher Exposition wurde ein 65jähringer Baum gefällt. Die ganze Höhe des Baumes betrug 12 m, die Länge des astlosen Schaftes 7 m und der durchschnittliche Durchmesser in Brusthöhe 26 cm. Der Stamm war sehr astrein und ziemlich vollhölzig und der Jahrringbau ungefähr concentrisch.

Acer palmatum (*Momiji*).

In demselben Standort mit der Yoguso-minebari fand ich auch eine 60jähringe Momiji, welche daher unter denselben Verhältnissen erwachsen war. Die ganze Höhe des Baumes betrug 12 m, die Länge des astfreien Schaftes 4 m. und der durchschnittliche Durchmesser in Brusthöhe 30,2 cm.

Der Stamm war sehr astreich und der Jahrringbau excentrisch.

Fagus japonica (*Inu-buna*).

Unmittelbar an dem vorigen Bestand angrenzend und zwar bei einer Neigung von ca. 30° und einer südwestlichen Exposition fand sich auch eine 60jährige Inu-buna, die unter ähnlichen Schlussverhältnissen erwachsen war, wie die beiden vorgenannten Stämme.

Die ganze Höhe des Stammes betrug 12 m, die Länge des astlosen Schaftes 3,5 m und der durchschnittliche Durch-

messer in Brusthöhe 24 cm. Der Stamm war sehr astreich und der Jahrringbau etwas excentrisch.

Halesia Corymbosum (*Asagara*).

Auf einem Hange mit einer Neigung von ca. 25° und einer nordöstlichen Exposition wurde eine 50jährige Asagara gefällt, welch von Jugend auf etwas licht erwachsen war. Der Stamm war sehr astreich und der Jahrringbau sehr excentrisch. Die Gesammthöhe betrug 13 m, die Schaftslänge bis zum Kronenansatz 5 m und der durchschnittliche Durchmesser in Brusthöhe 21,5 cm.

III. Methode der Untersuchung des Klemmens.

Es ist selbstredend, dass, wenn die Resultate einer Untersuchung mit Ergebnissen der von Anderen angestellten ähnlichen Untersuchungen über einen Gegenstand verglichen werden sollen, man wohl denselben Weg einschlagen muss, wo es sich nicht darum handelt die Constanz einer Erscheinung festzustellen. Bei der Untersuchung über das Klemmen habe ich aber nicht immer denselben Weg inne gehalten, wie z.B. Nördlinger vorgeschrieben hat. Da ich während der Versuche gemachte Erfahrungen zur Verbesserung der Verfahrungsweise bei späteren Experiementen verwendet habe, liegt mir nun ob das von mir beobachtete Verfahren zu schildern.

Unmittelbar nach der Fällung der Bäume entnahm ich von den einzelnen Stämmen 4 oder 5 Scheiben ca. 1 cm. Dicke in verschiedenen Baumhöhen und in den nach Süden gerichten Theil der Scheibe liess ich (Siehe Fig. I und II) eine Kluft in einer Breite von 1 cm. vom Umfang bis zum Mittelpunkt ausschneiden und dann mass ich die Abstände, um welche je zwei zu beiden Seiten der Kluft befindliche Punkte zusammengerückt sind.

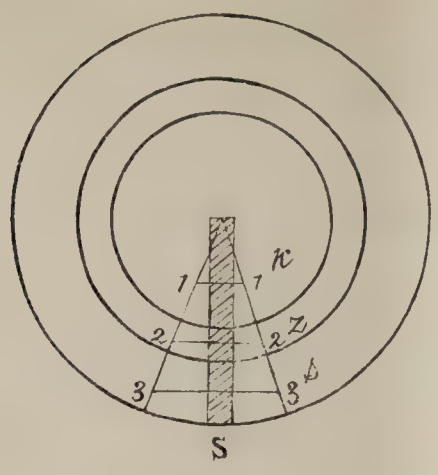

Fig. I.

k Kernholz.
z Zwischenzone.
s Splintholz.

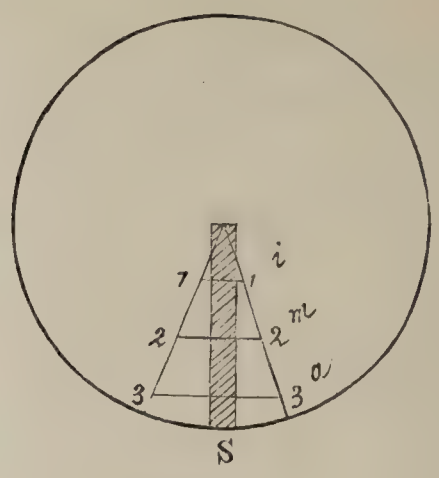

Fig. II.

i Innerer Theil.
m Mittler Theil.
a Aeusserer Theil.

Der schraffierte Theil der Figuren zeigt den Sägschnitt und 1–1, 2–2 und 3–3 sind die gemessenen Entfernungen.

Bei Hölzern wie Akamatsu und Karamatsu, welche einen deutlichen Farbenunterschied zwischen dem Kern und Splint zeigen, habe ich das Klemmen in Splintholz, Zwischenzone und Kernholz und zwar im Mittelpunkte jeder zone, wie in Fig. I. gemessen.

Bei Urashiro-momi, Shirakaba u. dgl., wobei der äussere und innere Theil dieselbe Färbung zeigen, habe ich das Klemmen im äusseren, mittleren und inneren Theile mit einer bestimmten Entfernung vom Mittelpunkt gegen den Umfang gemessen.

Der Einfluss der Rinde auf das Klemmen wurde durch Untersuchung der in fast gleichen Höhen über dem Boden sich befindlichen d.h. dicht neben einander abgesägten Scheiben festgestellt, in denen die eine mit Rinde und die andere ohne Rinde blieb.

Das Verhältniss des Klemmens zur Länge des Sägschnitts wurde besonders durch Untersuchung der Scheiben von Urashiro-momi und Karamatsu klargelegt.

Bei dem Material, welches ich in der Nähe von Umakayeshi nahm, wurde einige Abweichungen von dem vorerwähnten Verfahren vorgenommen in Bezug auf die Ziehung der Grundlinien und zwar habe ich statt der dreieckigen Form zwei Parallel linien mit der Distanz von 3 cm von einander vom Mittelpunkt gegen die Rinde wie Fig. III. und IV.

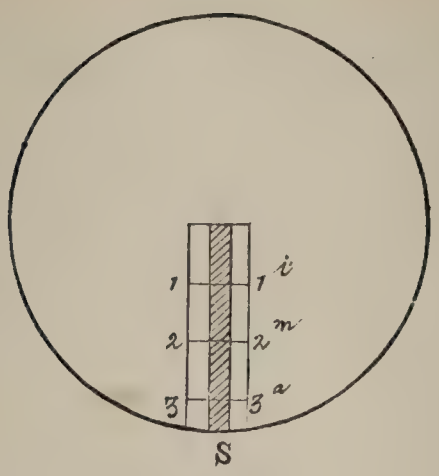

Fig. III.

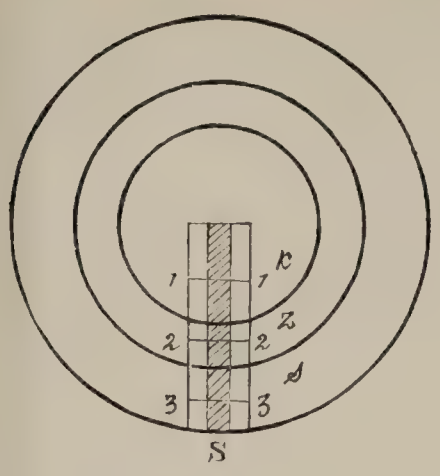

Fig. IV.

Um die Beziehung des Klemmens zur Dicke der Scheiben zu ermitteln, wurde zunächst 1 m von dem unteren Schnittrande des Stammes, also in ungefähr 1,3 m Höhe über dem Boden 5 Scheiben mit einer allmählich zunehmenden Dicke 1, 2, 3, 4 und 5 cm von jeder Holzart herausgeschnitten und in der nämlichen Weise untersucht.

Um zu prüfen, ob das Klemmen in der Linie eines einzigen Sägschnitts des Gesammt-klemmen im ganzen Umfang der Scheibe ausdrücke, wurden Scheiben von Tsuga, Yoguso-minebari, Momiji, Inu-buna und Asagara zur Untersuchung benutzt.

Diese Scheiben wurden in 2 m Höhe vom Fuss entnommen und an jeder derselben wurden vier Sägschnitte nach der Himmelrichtung von 7 cm Länge gegen dem Mittelpunkt zugeführt wie es in Fig. V. zeigt.

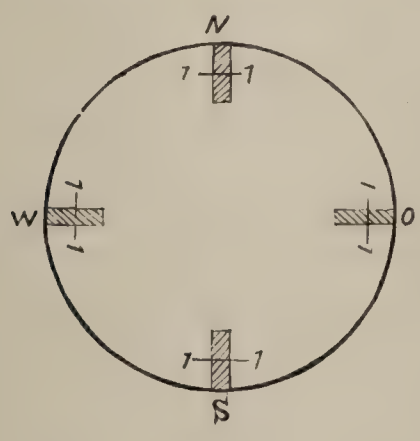

Fig. V.

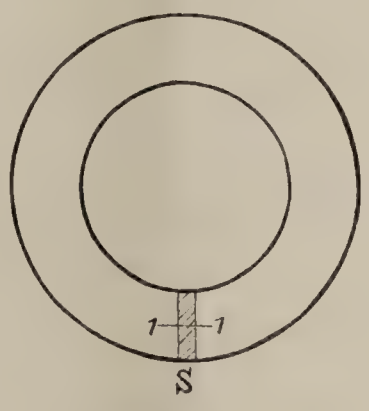

Fig. VI.

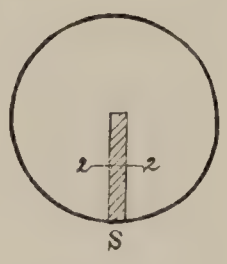

Fig. VII.

Eigentlicher Splintring. Eigentlicher Kerntheil.

Der schraffierte Theil der Figuren zeigt dem Sägschnitt und 1–1, 2–2, sind die im Splint oder äusseren Theil bei Fig. V. und VI. und in der Mitte des Kerntheiles bei Fig. VII. gemessenen Entfernungen.

Die Grösse des Klemmens von eigentlichem Splint und Kernholz für sich, untersuchte ich an Scheiben von Asagara und Yoguso-minebari, aus welchen je ein Splintring und Kerntheil (aus einer und derselben Scheibe wie in Fig. VI. und VII. dargestellt) herausgearbeitet worden waren.

IV. Resultate der Untersuchung.

Die nach den so beschriebenen Methoden erhaltenen Resultate sind in Einzeltabellen nachfolgend zusammengestellt.

V. Ergebnisse der Untersuchungen.

Fassen wir die Hauptergebnisse der vorliegenden Arbeit hier kurz zusammen, so finden wir:

1. Das Klemmen tritt bei jeder Holzart ohne Ausnahme mehr oder weniger auf.
2. Das Mass der Klemmung ist sehr verschieden, je nach Holzarten, aber bei ein und derselben Gattung annähernd übereinstimmend.
3. Das Klemmen ist nicht vorübergehend, sondern hält so lange an, bis in Folge der Verdunstung das Schwinden beginnt und bis auf diesen Zeitpunkt nimmt das Klemmungsmass allmählig zu.
4. Die Dauer des Klemmens ist verschieden, je nach Holzarten, nach der Dicke einer Scheibe, ferner verschieden bei berindeten und bei entrindeten Scheiben. Je dicker eine Scheibe ist, desto länger dauert das Klemmen an. Die Klemmungsdauer ist grösser bei berindeten Scheiben als bei unberindeten.
5. Die Grad des Klemmens nimmt vom Mittelpunkt des Stammes gegen die Rinde hin stetig zu. (Siehe Tab. I–V.)
6. Das Klemmungsmass wird durch die Rinde erheblich vermindert, namentlich ist der Einfluss der Rinde beim Splintholz grösser, als bei den anderen Holztheilen. Das Klemmen wird nämlich um so kräftiger behindert, je dicker der Bau der Rinde ist.

7. Die Dicke einer Scheibe übt keinen grossen Einfluss auf die Klemmungsgrösse aus. (Siehe Tab. XIII.–XVII.)
8. Bei losgetrenntem Splintholz (Splintholz für sich untersucht) ist die Klemmung immer grösser, als beim Splintholz einer vollen Scheibe. Dagegen zeigt der vom Splint befreite Kern (Kernholz für sich) kein anderes Klemmungsmass als das Kernholz der vollen Scheibe. (Siehe Tab. XVIII. und XIX.)
9. Das Klemmen in der Linie eines einzigen Sägschnitts entspricht annähernd dem Gesammtklemmen im ganzen Umfange, (Siebe Tab. XX.)
10. Das Klemmmass einer und derselben Scheibe wird durch die Länge des Sägeschnitts sehr bedeutend beeinflusst, indem es um so grösser ist, je länger die Kluft (vom Umfang der Scheibe gegen den Mittelpunkt zu) ist. (Vergleiche Tab. II. zu I. und Tab. V. zu IV.)

Es geht nun aus den Untersuchungsresultaten der im Kap. II. angegebenen letzten fünf Bäume eine bemerkenswerthe Thatsache hervor, dass das Klemmmass des Kern-, Mittel- und Splintholzes sich etwa wie 1 ; 2 ; 3 verhält, so dass man annehmen könnte, dass das Klemmensmass durch eine lineare Function von der Länge des Sägschnitts dargestellt werden könne. Nennt man nun die Grösse des Klemmens δ die Länge des Sägschnitts r und eine Constante a, so wird diese Annahme in folgender Form ausgedrückt.

$$\delta = a\, r$$

Um nun zu prüfen, soweit diese Annahme sich der Natur anpassen lässt, habe ich mit gütiger Unterstützung von Herrn Prof. Dr. Kitao mittelst der kleinsten Quadrate folgende Resultate erhalten.

I. ACER PALMATUM (*Momiji*).

a=0,0094.

No. der Scheibe.	Distanz cm.	Gemessene cm.	Berechnete cm.	Fehler cm.	Bemerkungen.
I.	12	0,12	0,1128	−0,0072	Der wahrscheinlichste Werth des wahrscheinlichen Fehlers f=0,0050
	8	0,07	0,0752	+0,0052	
	4	0,03	0,0376	+0,0076	
II.	12	0,12	0,1128	−0,0072	
	8	0,06	0,0752	+0,0152	
	4	0,03	0,0376	+0,0076	
III.	12	0,12	0,1128	−0,0072	
	8	0,07	0,0752	+0,0052	
	4	0,04	0,0376	−0,0024	
IV.	12	0,12	0,1128	−0,0072	
	8	0,07	0,0752	+0,0052	
	4	0,03	0,0376	+0,0076	
V.	12	0,12	0,1128	−0,0072	
	8	0,07	0,0752	+0,0052	
	4	0,04	0,0376	−0,0024	

II. HALESIA CORYMBOSUM (*Asagara*).

a=0,0102.

No. der Scheibe.	Distanz cm.	Gemessene cm.	Berechnete cm.	Fehler cm.	Bemerkungen.
I.	9	0,09	0,0918	+0,0018	f=0,0056
	6	0,05	0,0612	+0,0112	
	3	0,03	0,0306	+0,0006	
II.	9	0,09	0,0918	+0,0018	
	6	0,05	0,0612	+0,0112	
	3	0,02	0,0306	+0,0106	
III.	9	0,10	0,0918	−0,0082	
	6	0,05	0,0612	+0,0112	
	3	0,03	0,0306	+0,0006	
IV.	9	0,11	0,0918	−0,0182	
	6	0,06	0,0612	+0,0012	
	3	0,03	0,0306	+0,0006	
V.	9	0,10	0,0918	−0,0082	
	6	0,06	0,0612	+0,0012	
	3	0,03	0,0306	+0,0006	

III. BETULA ULMIFOLIA (*Yoguso-minebari*).

a=0,0104.

No. der Scheibe.	Distanz cm.	Gemessene cm.	Berechnete cm.	Fehler cm.	Bemerkungen.
I.	9,5	0,09	0,0988	+0,0088	f=0,0037
	6,5	0,06	0,0676	+0,0076	
	3,0	0,03	0,0312	+0,0012	
II.	9,5	0,10	0,0988	−0,0012	
	6,5	0,07	0,0676	−0,0024	
	3,0	0,03	0,0312	+0,0012	
III.	9,5	0,10	0,0988	−0,0012	
	6,5	0,06	0,0676	+0,0076	
	3,0	0,03	0,0312	+0,0012	
IV.	9,5	0,10	0,0988	−0,0012	
	6,5	0,07	0,0676	−0,0024	
	3,0	0,03	0,0312	+0,0012	
V.	9,5	0,11	0,0988	−0,0112	
	6,5	0,07	0,0676	−0,0024	
	3,0	0,04	0,0312	−0,0088	

IV. FAGUS JAPONICA (*Inu-buna*).

a=0,0126.

No. der Scheibe.	Distanz cm.	Gemessene cm.	Berechnete cm.	Fehler cm.	Bemerkungen.
I.	9	0,12	0,1134	−0,0066	f=0,00341
	6	0,08	0,0756	−0,0044	
	3	0,04	0,0378	−0,0022	
II.	9	0,11	0,1134	+0,0034	
	6	0,08	0,0756	−0,0044	
	3	0,04	0,0378	−0,0022	
III.	9	0,11	0,1134	+0,0034	
	6	0,08	0,0756	−0,0044	
	3	0,04	0,0378	−0,0022	
IV.	9	0,11	0,1134	+0,0034	
	6	0,08	0,0756	−0,0044	
	3	0,03	0,0378	+0,0078	
V.	9	0,11	0,1134	+0,0034	
	6	0,08	0,0756	−0,0044	
	3	0,03	0,0378	+0,0078	

V. TSUGA SIEBOLDII (*Tsuga*).

No. der Scheibe.	Distanz cm.	Gemessene cm.	Berechnete cm.	Fehler cm.	Bemerkungen,
		a=0,0098.			
I.	9	0,10	0,0882	−0,0118	f=0,00998
	6	0,05	0,0588	+0,0088	
	3	0,01	0,0294	+0,0194	
II.	9	0,09	0,0882	−0,0018	
	6	0,04	0,0588	+0,0188	
	3	0,01	0,0294	+0,0194	
III.	9	0,10	0,0882	−0,0118	
	6	0,05	0,0588	+0,0088	
	3	0,01	0,0294	+0,0194	
IV.	9	0,10	0,0882	−0,0118	
	6	0,07	0,0588	−0,0112	
	3	0,01	0,0294	+0,0194	
V.	9	0,10	0,0882	−0,0118	
	6	0,06	0,0588	−0,0012	
	3	0,01	0,0294	+0,0194	

Wenn man bei dieser geringen Anzahl der untersuchten Scheiben zu einem allgemeinen Schluss berechtigt wäre, so kann man sich bei diesem Werth des wahrscheinlichen Fehlers der Thatsache nicht verschliessen, dass das Klemmmass sich in der That mit grosser Annäherung durch eine lineare Function von der Länge des Sägschnittes darstellen lässt, da doch die Fehler wie der Vergleich ihrer Werthe mit dem wahrscheinlichsten Werthe des wahrscheinlichen Fehlers zeigt, Grössen haben, die fast ebenso oft über wie unter (f) liegen, also dass man wohl berechtigt ist, die Abweichungen zwischen dem beobachteten und berechneten Klemmen dem unvermeidlichen Beobachtungsfehler zuzuschreiben, der freilich bei der keine allzu grosse Genauigkeit gestattenden Messungsmethode, wie bei der Geringfügigkeit der zu messenden Länge sicher ein bedeutender sein möchte.

I. LARIX LEPTOLEPIS (*Karamatsu*).

No. der Scheibe.	Baumhöhe m.	Durchschnittlicher Durchmesser der Scheibe cm.	Länge des Sägschnittes vom Mark bis zum Umfang cm.	Bezeichnung der Holzstücke.	Volle Scheibe mit Rinde.				Volle Scheibe ohne Rinde.				BEMERKUNGEN.
					Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	
I.	1	28,5	16,4	Splintholz	4,50	4,31	0,19	4,2	4,65	4,44	0,21	4,5	
				Zwischenzone	3,47	3,32	0,15	4,3	3,58	3,41	0,17	4,7	
				Kernholz	1,48	1,44	0,04	2,7	1,55	1,49	0,06	3,8	
II.	7	24,0	12,5	Splintholz	3,83	3,68	0,15	3,9	3,92	3,73	0,17	4,3	
				Zwischenzone	2,63	2,52	0,11	4,1	2,62	2,50	0,12	4,5	
				Kernholz	1,42	1,39	0,03	2,1	1,45	1,40	0,05	3,4	
III.	10	22,0	11,1	Splintholz	4,04	3,90	0,14	3,4	3,99	3,83	0,16	4,0	
				Zwischenzone	2,84	2,73	0,11	3,8	2,61	2,50	0,11	4,2	
				Kernholz	1,70	1,65	0,05	2,9	1,57	1,51	0,06	3,8	
IV.	13	20,0	10,5	Splintholz.	3,74	3,58	0,16	4,2	3,77	3,60	0,17	4,7	
				Zwischenzone	2,50	2,40	0,10	4,0	2,59	2,48	0,11	4,2	
				Kernholz	1,74	1,70	0,04	2,3	1,59	1,74	0,05	3,1	

II. LARIX LEPTOLEPIS (*Karamatsu*).

No. der Scheibe.	Baumhöhe m.	Durchschnittlicher Durchmesser der Scheibe cm.	Länge des Sägschnittes vom Mark bis zum Umfang cm.	Bezeichnung der Holzstücke.	Volle Scheibe mit Rinde.				Volle Scheibe ohne Rinde.				BEMERKUNGEN.
					Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	
I.	1	28,5	11,7	Splintholz	4,50	4,33	0,17	3,8	4,65	4,47	0,18	3,9	
				Zwischenzone	3,47	3,37	0,10	2,6	3,58	3,47	0,11	3,0	
				Kernholz	1,48	1,46	0,02	1,3	1,55	1,51	0,04	2,5	
II.	7	24,0	9,7	Splintholz	3,83	3,71	0,12	3,1	3,92	3,78	0,14	3,5	
				Zwischenzone	2,63	2,55	0,08	3,0	2,62	2,54	0,08	3,0	
				Kernholz	1,42	1,40	0,02	1,4	1,45	1,42	0,03	2,0	
III.	10	22,0	8,7	Splintholz	4,04	3,94	0,10	2,4	3,99	3,88	0,11	2,7	
				Zwischenzone	2,84	2,77	0,07	2,4	2,61	2,53	0,08	3,0	
				Kernholz	1,70	1,67	0,03	1,7	1,57	1,53	0,04	2,5	
IV.	13	20,0	7,7	Splintholz	3,74	3,65	0,09	2,4	3,77	3,67	0,10	2,6	
				Zwischenzone	2,50	2,43	0,07	2,8	2,59	2,51	0,08	3,0	
				Kernholz	1,74	1,72	0,02	1,1	1,79	1,76	0,03	1,7	

III. PINUS DENSIFLORA (*Akamatsu*).

No. der Scheibe.	Baumhöhe m.	Durchschnittlicher Durchmesser der Scheibe cm.	Länge des Sägschnittes vom Mark bis zum Umfang cm.	Bezeichnung der Holzstücke.	Volle Scheibe mit Rinde.				Volle Scheibe ohne Rinde.				BEMERKUNGEN.
					Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	
I.	2	33,3	18,0	Splintholz	4,41	4,22	0,19	4,3	4,31	4,11	0,20	4,6	
				Zwischenzone	3,32	3,18	0,14	4,0	3,31	3,17	0,14	4,2	
				Kernholz	1,66	1,60	0,06	3,6	1,70	1,64	0,06	3,5	
II.	4	30,5	17,0	Splintholz	4,26	4,09	0,17	4,0	4,30	4,10	0,20	4,6	
				Zwischenzone	3,23	3,10	0,13	4,0	3,20	3,05	0,15	4,6	
				Kernholz	1,70	1,64	0,06	3,5	1,72	1,66	0,06	3,5	
III.	6	29,0	15,8	Splintholz	4,37	4,20	0,17	4,0	4,34	4,14	0,20	4,6	
				Zwischenzone	3,46	3,33	0,13	3,8	3,45	3,29	0,16	4,6	
				Kernholz	1,73	1,67	0,06	3,5	1,81	1,74	0,07	3,9	
IV.	8	27,3	12,9	Splintholz	4,21	4,06	0,15	3,6	4,22	4,05	0,17	4,0	
				Zwischenzone	3,13	3,02	0,11	3,5	3,29	3,16	0,13	3,9	
				Kernholz	1,58	1,53	0,05	3,1	1,59	1,53	0,06	3,7	
V.	10	25,9	12,7	Splintholz	4,22	4,07	0,15	3,6	4,23	4,06	0,17	4,0	
				Zwischenzone	3,17	3,06	0,11	3,4	3,11	2,98	0,13	4,0	
				Kernholz	1,55	1,50	0,05	3,2	1,52	1,46	0,06	3,9	

IV. ABIES UMBELLATA (*Urashiromomi*).

No. der Scheibe.	Baumhöhe m.	Durchschnittlicher Durchmesser der Scheibe cm.	Länge des Sägschnittes vom Mark bis zum Umfang cm.	Bezeichnung der Holzstücke.	Volle Scheibe mit Rinde.				Volle Scheibe ohne Rinde.				BEMERKUNGEN.
					Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	
I.	0,3	31,5	16,5	Aeusserer Theil	4,50	4,32	0,18	4,0	4,51	4,29	0,22	4,8	
				Mittler Theil	3,05	2,93	0,12	3,9	3,01	2,86	0,15	4,6	
				Innerer Theil	1,58	1,54	0,04	2,5	1,55	1,50	0,05	3,2	
II.	2,3	29,5	15,1	Aeusserer Theil	4,08	3,92	0,16	4,1	4,08	3,89	0,19	4,6	
				Mittler Theil	2,73	2,62	0,11	4,0	2,75	2,63	0,12	4,4	
				Innerer Theil	1,41	1,36	0,05	3,5	1,45	1,40	0,05	3,4	
III.	4,3	29,0	14,3	Aeusserer Theil	4,23	4,07	0,16	4,0	4,26	4,08	0,18	4,2	
				Mittler Theil	2,87	2,76	0,11	3,8	2,91	2,79	0,12	4,0	
				Innerer Theil	1,44	1,40	0,04	2,7	1,52	1,47	0,05	3,3	
IV.	6,3	27,0	12,7	Aeusserer Theil	4,41	4,26	0,15	3,4	4,43	4,26	0,17	3,9	
				Mittler Theil	3,22	3,12	0,10	3,1	3,23	3,11	0,12	3,7	
				Innerer Theil	1,60	1,56	0,04	2,5	1,68	1,63	0,05	2,4	
V.	8,3	25,0	13,1	Aeusserer Theil	3,90	3,75	0,15	3,9	4,47	4,29	0,18	4,0	
				Mittler Theil	2,85	2,74	0,11	3,8	3,01	2,89	0,12	4,0	
				Innerer Theil	1,44	1,40	0,04	2,7	1,56	1,51	0,05	3,1	

V. ABIES UMBELLATA (*Urashiromomi*).

No. der Scheibe.	Baumhöhe m.	Durchschnittlicher Durchmesser der Scheibe cm.	Länge des Sägschnittes vom Mark bis zum Umfang cm.	Bezeichnung der Holzstücke.	Volle Scheibe mit Rinde.				Volle Scheibe ohne Rinde.				BEMERKUNGEN.
					Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	
I.	0,3	31,5	13,0	Aeusserer Theil	4,50	4,35	0,15	3,3	4,51	4,32	0,19	4,2	
				Mittler Theil	3,05	2,97	0,08	2,6	3,01	2,92	0,09	3,0	
				Innerer Theil	1,58	1,55	0,03	1,9	1,55	1,51	0,04	2,5	
II.	2,3	29,5	12,0	Aeusserer Theil	4,08	3,94	0,14	3,4	4,08	3,92	0,16	3,9	
				Mittler Theil	2,73	2,66	0,07	2,5	2,75	2,67	0,08	2,9	
				Innerer Theil	1,41	1,39	0,02	1,4	1,45	1,42	0,03	1,4	
III.	4,3	29,0	11,0	Aeusserer Theil	4,23	4,14	0,09	2,1	4,26	4,14	0,12	2,3	
				Mittler Theil	2,87	2,80	0,07	2,4	2,91	2,83	0,08	2,7	
				Innerer Theil	1,44	1,42	0,02	1,3	1,52	1,49	0,03	1,9	
IV.	6,3	27,0	10,0	Aeusserer Theil	4,41	4.33	0,08	1,8	4,43	4,32	0,11	2,4	
				Mittler Theil	3,22	3,17	0,05	1,5	3,23	3,17	0,06	1,8	
				Innerer Theil	1,60	1,58	0,02	1,2	1,68	1,65	0,03	1,8	
V.	8,3	25,0	10,0	Aeusserer Theil	3,90	3,80	0,10	2,5	4,47	4,34	0,13	2,9	
				Mittler Theil	2,85	2,77	0,08	2,8	3,01	2,92	0,09	3,0	
				Innerer Theil	1,44	1,42	0,02	1,4	1,56	1,53	0,03	1,9	

VI. CRYPTOMERIA JAPONICA (*Sugi*).

No. der Scheibe.	Baumhöhe m.	Durchschnittlicher Durchmesser der Scheibe cm.	Länge des Sägschnittes vom Mark bis zum Umfang cm.	Bezeichnung der Holzstücke.	Volle Scheibe mit Rinde. Sehnenlänge vor dem Schnitte cm.	Volle Scheibe mit Rinde. Sehnenlänge nach dem Schnitte cm.	Volle Scheibe mit Rinde. Klemmungsgrösse cm.	Volle Scheibe mit Rinde. %	Volle Scheibe ohne Rinde. Sehnenlänge vor dem Schnitte cm.	Volle Scheibe ohne Rinde. Sehnenlänge nach dem Schnitte cm.	Volle Scheibe ohne Rinde. Klemmungsgrösse cm.	Volle Scheibe ohne Rinde. %	BEMERKUNGEN.
I.	2	25,3	15,3	Splintholz	4,51	4,41	0,10	2,2	4,37	4,26	0,11	2,5	
				Zwischenzone	3,58	3,50	0,08	2,2	3,53	3,45	0,08	2,2	
				Kernholz	1,78	1,76	0,02	1,1	1,80	1,77	0,03	1,6	
II.	4	23,5	13,0	Splintholz	4,22	4,12	0,10	2,3	4,27	4,16	0,11	2,5	
				Zwischenzone	3,24	3,16	0,08	2,4	3,21	3,13	0,08	2,5	
				Kernholz	1,64	1,62	0,02	1,2	1,49	1,47	0,02	2,0	
III.	6	21,5	12,1	Splintholz	4,17	4,07	0,10	2,4	4,09	3,98	0,11	2,6	
				Zwischenzone	3,03	2,96	0,07	2,3	3,10	3,02	0,08	2,5	
				Kernholz	1,60	1,58	0,02	1,2	1,48	1,46	0,02	2,0	
IV.	8	20,5	10,7	Splintholz	4,07	3,97	0,10	2,4	4,07	3,96	0,11	2,6	
				Zwischenzone	3,01	2,94	0,07	2,3	3,06	2,98	0,08	2,6	
				Kernholz	1,66	1,64	0,02	1,2	1,53	1,51	0,02	1,9	
V.	10	19,3	9,8	Splintholz	4,01	3,91	0,10	2,4	3,95	3,84	0,11	2,6	
				Zwischenzone	2,90	2,88	0,07	2,3	2,92	2,85	0,07	2,4	
				Kernholz	1,48	1,46	0,02	1,3	1,17	1,67	0,03	1,6	

VII. CHAMAECYPARIS OBTUSA (*Hinoki*).

No. der Scheibe.	Baumhöhe m.	Durchschnittlicher Durchmesser der Scheibe cm.	Länge des Sägschnittes vom Mark bis zum Umfang cm.	Bezeichnung der Holzstücke.	Volle Scheibe mit Rinde.				Volle Scheibe ohne Rinde.				BEMERKUNGEN.
					Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	
I.	2	23,0	10,3	Splintholz	4,54	4,43	0,11	2,4	4,60	4,48	0,12	2,6	
				Zwischenzone	3,85	3,75	0,10	2,5	3,80	3,80	0,10	2,6	
				Kernholz	2,07	2,04	0,03	1,4	1,80	1,77	0,03	1,7	
II.	4	22,5	10,8	Splintholz	4,56	4,45	0,11	2,4	4,57	4,45	0,12	2,6	
				Zwischenzone	3,95	3,86	0,09	2,3	3,93	3,83	0,10	2,5	
				Kernholz	2 15	2,12	0,03	1,4	1,87	1,84	0,03	1,6	
III.	6	20,5	10,0	Splintholz	4,51	4,40	0,11	2,4	4,59	4,47	0,12	2,6	
				Zwischenzone	3,80	3,72	0,08	2,1	3,82	3,73	0,09	2,3	
				Kernholz	2,02	2,90	0,02	1,0	2,10	2,07	0,02	1,4	
IV.	8	20,0	9,7	Splintholz	4,44	4,34	0,10	2,3	4,43	4,32	0,11	2,4	
				Zwischenzone	3,73	3,65	0,08	2,1	3,66	3,57	0,09	2,4	
				Kernholz	1,80	1,78	0,02	1,1	1,97	1,95	0,02	1,5	
V.	10	19,0	9,8	Splintholz	4,57	4,46	0,11	2,4	4,34	4,23	0,11	2,5	
				Zwischenzone	3,75	3,66	0,09	2,4	3,70	3,61	0,09	2,4	
				Kernholz	1,92	1,89	0,03	1,5	1,88	1,85	0,03	1,6	

VIII. BETULA ALBA, var VULGARIS (*Shirakaba*).

No. der Scheibe.	Baumhöhe m.	Durchschnittlicher Durchmesser der Scheibe cm.	Länge des Sägschnittes vom Mark bis zum Umfang cm.	Bezeichnung der Holzstücke.	Volle Scheibe mit Rinde. Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	Volle Scheibe ohne Rinde. Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	BEMERKUNGEN.
I.	1	23,0	10,6	Aeusserer Theil	4,55	4,47	0,08	1,7	4,46	4,35	0,11	2,4	
				Mittler Theil	3,06	3,01	0,05	1,6	2,96	2,90	0,06	2,0	
				Innerer Theil	1,53	1,51	0,02	1,3	1,54	1,51	0,03	1,9	
II.	2	22,0	12,2	Aeusserer Theil	3,95	3,87	0,08	2,0	3,97	3,87	0,10	2,5	
				Mittler Theil	2,65	2,60	0,05	1,8	2,66	2,60	0,06	2,2	
				Innerer Theil	1,35	1,33	0,02	1,4	1,36	1,34	0,02	1,4	
III.	3	22,0	10,8	Aeusserer Theil	4,55	4,47	0,08	1,7	4,82	4,72	0,10	2,0	
				Mittler Theil	3,05	3,00	0,05	1,6	3,20	3,14	0,06	1,8	
				Innerer Theil	1,54	1,52	0,02	1,3	1,62	1,60	0,02	1,2	
IV.	4	20,8	9,3	Aeusserer Theil	4,38	4,30	0,08	1,8	4,35	4,25	0,10	2,3	
				Mittler Theil	2,91	2,87	0,04	1,3	2,94	2,87	0,07	2,3	
				Innerer Theil	1,49	1,47	0,02	1,3	1,45	1,42	0,03	2,0	
V.	5	20,5	10,0	Aeusserer Theil	4,12	4,05	0,07	1,7	4,00	3,91	0,09	2,5	
				Mittler Theil	2,76	2,71	0,05	1,7	2,69	2,62	0,07	2,5	
				Innerer Theil	1,38	1,35	0,03	2,1	1,37	1,34	0,03	2,1	

IX. MAGNOLIA HYPOLEUCA (*Hohonoki*).

No. der Scheibe.	Baumhöhe m.	Durchschnittlicher Durchmesser der Scheibe cm.	Länge des Sägschnittes vom Mark bis zum Umfang cm.	Bezeichnung der Holzstücke.	Volle Scheibe mit Rinde.				Volle Scheibe ohne Rinde.				BEMERKUNGEN.
					Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	
I.	0,3	32,0	12,5	Splintholz	4,31	4,31	0,00	0,0	4,19	4,16	0,03	0,7	
				Zwischenzone	3,29	3,29	0,00	0,0	3,33	3,31	0,02	0,6	
				Kernholz	1,78	1,78	0,00	0,0	1,76	1,76	0,00	0,0	
II.	2,3	27,5	12,2	Splintholz	4,05	4,05	0,00	0,0	4,15	4,12	0,03	0,7	
				Zwischenzone	3,04	3,04	0,00	0,0	2,10	3,08	0,02	0,6	
				Kernholz	1,43	1,43	0,00	0,0	1,50	1,49	0,01	0,7	
III.	4,3	24,5	10,8	Splintholz	3,88	4,88	0,00	0,0	3,99	3,93	0,06	1,5	
				Zwischenzone	2,93	3,93	0,00	0,0	2,94	2,90	0,04	1,4	
				Kernholz	1,57	1,57	0,00	0,0	1,50	1,48	0,02	1,3	
IV.	6,3	22,8	9,4	Splintholz	4,07	4,05	0,02	0,5	4,11	4,05	0,06	1,5	
				Zwischenzone	3,05	3,04	0,01	0,3	3,19	3,14	0,05	1,5	
				Kernholz	1,65	1,65	0,00	0,1	1,66	1,64	0,02	1,2	
V.	8,3	22,3	9,3	Splintholz	4,03	4,00	0,03	0,7	3,91	3,85	0,06	1,5	
				Zwischenzone	2,87	2,85	0,02	0,7	2,91	2,86	0,05	1,5	
				Kernholz	1,56	1,55	0,01	0,6	1,49	1,47	0,02	1,3	

X. PRUNUS CERASOIDES (*Mejirosakura*).

No. der Scheibe.	Baumhöhe m.	Durchschnittlicher Durchmesser der Scheibe cm.	Länge des Sägschnittes vom Mark bis zum Umfang cm.	Bezeichnung der Holzstücke.	Volle Scheibe mit Rinde. Sehnenlänge vor dem Schnitte cm.	Volle Scheibe mit Rinde. Sehnenlänge nach dem Schnitte cm.	Volle Scheibe mit Rinde. Klemmungsgrösse cm.	Volle Scheibe mit Rinde. %	Volle Scheibe ohne Rinde. Sehnenlänge vor dem Schnitte cm.	Volle Scheibe ohne Rinde. Sehnenlänge nach dem Schnitte cm.	Volle Scheibe ohne Rinde. Klemmungsgrösse cm.	Volle Scheibe ohne Rinde. %	BEMERKUNGEN.
I.	0,3	22,5	6,7	Splintholz	4,38	4,34	0,04	0,9	4,22	4,17	0,05	1,2	
				Zwischenzone	3,47	3,44	0,03	0,9	3,44	3,40	0,04	1,1	
				Kernholz	1,65	1,63	0,02	1,2	1,99	1,97	0,02	1,0	
II.	2,3	20,5	7,8	Splintholz	4,39	4,34	0,05	1,1	4,26	4,20	0,06	1,4	
				Zwischenzone	3,54	4,50	0,04	1,1	3,54	3,49	0,05	1,4	
				Kernholz	1,70	1,68	0,02	1,1	1,70	1,68	0,02	1,1	
III.	4,3	19,3	6,9	Splintholz	4,34	4,28	0,06	1,3	4,33	4,26	0,07	1,6	
				Zwischenzone	3,47	3,43	0,04	1,1	3,54	3,49	0,05	1,4	
				Kernholz	1,80	1,78	0,02	1,1	1,75	1,73	0,02	1,1	
IV.	6,3	18,3	8,1	Splintholz.	4,34	4,28	0,06	1,3	3,95	3,89	0,06	1,5	
				Zwischenzone	3,55	3,50	0,05	1,4	3,23	3,18	0,05	1,5	
				Kernholz	1,79	1,77	0,02	1,1	1,70	1,68	0,02	1,1	

XI. ZELKOWA KEAKI (*Keaki*).

No. der Scheibe.	Baumhöhe m.	Durchschnittlicher Durchmesser der Scheibe cm.	Länge des Sägschnittes vom Mark bis zum Umfang cm.	Bezeichnung der Holzstücke.	Volle Scheibe mit Rinde.				Volle Scheibe ohne Rinde.				BEMERKUNGEN.
					Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	
I.	0,3	35,0	16,1	Splintholz	4,29	4,20	0,09	2,1	4,32	4,20	0,12	2,8	
				Zwischenzone	3,39	3,32	0,07	2,1	3,50	3,40	0,10	2,7	
				Kernholz	1,69	1,66	0,03	1,7	1,80	1,76	0,04	2,2	
II.	2,3	30,8	13,5	Splintholz	4,25	4,15	0,10	2,3	4,30	4,17	0,13	3,0	
				Zwischenzone	3,34	3,26	0,08	2,3	3,45	3,35	0,10	2,9	
				Kernholz	1,69	1,66	0,03	1,7	1,75	1,71	0,04	2,2	
III.	4,3	29,8	13,9	Splintholz	4,21	4,11	0,10	2,4	4,27	4,14	0,13	3,0	
				Zwischenzone	3,37	3,29	0,08	2,4	3,34	3,24	0,10	3,0	
				Kernholz	1,74	1,71	0,03	1,7	1,78	1,74	0,04	2,2	
IV.	6,3	29,0	14,2	Splintholz	4,35	4,24	0,11	2,5	4,31	4,18	0,13	3,0	
				Zwischenzone	3,47	3,39	0,08	2,3	3,49	3,38	0,11	3,0	
				Kernholz	1,70	1,67	0,03	1,7	1,71	1,67	0,04	2,3	
V.	8,3	29,5	14,2	Splintholz	4,22	4,12	0,10	2,4	4,14	4,01	0,13	3,1	
				Zwischenzone	3,20	3,13	0,07	2,2	3,21	3,11	0,10	3,0	
				Kernholz	1,70	1,67	0,03	1,7	1,68	1,64	0,04	2,3	

XII. JUGLANS SIEBOLDIANA (*Onikurumi*).

No. der Scheibe.	Baumhöhe m.	Durchschnittlicher Durchmesser der Scheibe cm.	Länge des Sägschnittes vom Mark bis zum Umfang cm.	Bezeichnung der Holzstücke.	Volle Scheibe mit Rinde. Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	Volle Scheibe ohne Rinde. Sehnenlänge vor dem Schnitte cm.	Sehnenlängenach dem Schnitte cm.	Klemmungsgrösse cm.	%	BEMERKUNGEN.
I.	0,3	28,5	12,6	Splintholz	4,69	4,66	0,03	0,6	4,75	4,70	0,05	1,0	
				Zwischenzone	4,26	4,24	0,02	0,5	4,25	4,22	0,03	0,7	
				Kernholz	2,28	2,28	0,00	0,0	2,14	2,13	0,01	0,4	
II.	2,3	24,8	10,5	Splintholz	4,73	4,70	0,03	0,6	4,72	4,67	0,05	1,1	
				Zwischenzone	4,24	4,22	0,02	0,5	4,28	4,24	0,04	0,9	
				Kernholz	2,05	2,05	0,00	0,0	2,22	2,21	0,01	0,4	
III.	4,3	24,0	9,8	Splintholz	4,85	4,81	0,04	0,8	4,74	4,68	0,06	1,2	
				Zwischenzone	4,38	4,35	0,03	0,7	4,30	4,26	0,04	0,9	
				Kernholz	2,23	2,22	0,01	0,4	1,99	1,98	0,01	0,5	
IV.	6,3	22,5	9,0	Splintholz	4,78	4,73	0,05	1,0	4,70	4,63	0,07	1,4	
				Zwischenzone	4,38	4,34	0 04	0,9	4,31	4,26	0,05	1,1	
				Kernholz	2,27	2,26	0,01	0,4	2,25	2,24	0,01	0,4	

XIII. FAGUS JAPONICA (*Inubuna*).

Volle Scheibe mit Rinde.										
No. der Scheibe in 1 m Höhe.	Dm. in 1 m Höhe cm.	Dick der Scheibe cm.	Länge des Sägschnitts vom Mark bis zum Umfang cm.	Distanz des Marks von Messpunkte cm.	Bezeichnung der Holzstücke.	Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	BEMERKUNGEN.
I.	24	1	II	9	Aeusserer Theil.....	3,00	2,88	0,12	4,0	
				6	Mittler Theil.....	3,00	2,92	0,08	2,6	
				3	Innerer Theil	3,00	2,96	0,04	1,3	
II.	24	2	II	9	Aeusserer Theil.....	3,00	2,89	0,11	3,6	
				6	Mittler Theil.....	3,00	2,92	0,08	2,6	
				3	Innerer Theil	3.00	2,96	0,04	1,3	
III.	24	3	II	9	Aeusserer Theil.....	3,00	2,89	0,11	3,6	
				6	Mittler Theil.....	3,00	2,92	0,08	2,6	
				3	Innerer Theil	3,00	2,96	0,04	1,3	
IV.	24	4	II	9	Aeusserer Theil.....	3,00	2,89	0,11	3,6	
				6	Mittler Theil.....	3.00	2,93	0,08	2,6	
				3	Innerer Theil	3,00	2,97	0,03	1,0	
V.	24	5	II	9	Aeusserer Theil.....	3,90	2,89	0,11	3,6	
				6	Mittler Theil.....	3,00	2,92	0,08	2,6	
				3	Innerer Theil	3,00	2,97	0,03	1,0	

XIV. ACER PALMATUM (*Momiji*).

Volle Scheibe mit Rinde.

No. der Scheibe in 1 m Höhe.	Dm. in 1 m Höhe cm.	Dick der Scheibe cm.	Länge des Sägschnitts vom Mark bis zum Umfang cm.	Distanz des Marks von Messpunkte cm.	Bezeichnung der Holzstücke.	Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	BEMERKUNGEN.
I.	30,2	1	13,4	12	Aeusserer Theil.....	3,00	2,88	0,12	4,0	
				8	Mittler Theil.....	3,00	2,93	0,07	2,3	
				4	Innerer Theil	3,00	2,97	0,03	1,0	
II.	30,2	2	13,4	12	Aeusserer Theil.....	3,00	2,88	0,12	4,0	
				8	Mittler Theil.....	3,00	2,94	0,06	2,0	
				4	Innerer Theil	3,00	2,97	0,03	1,0	
III.	30,2	3	13,4	12	Aeusserer Theil.....	3,00	2,88	0,12	4,0	
				8	Mittler Theil.....	3,00	2,93	0,07	2,3	
				4	Innerer Theil	3,00	2,96	0,04	1,3	
IV.	30,2	4	13,4	12	Aeusserer Theil.....	3,00	2,88	0,12	4,0	
				8	Mittler Theil.....	3,00	2,93	0,07	2,3	
				4	Innerer Theil	3,00	2,97	0,03	1,0	
V.	30,2	5	13,4	12	Aeusserer Theil.....	3,00	2,88	0,12	4,0	
				8	Mittler Theil.....	3,00	2,93	0,07	2,3	
				4	Innerer Theil	3,00	3,96	0,04	1,3	

XV. BETURA ULMIFOLIA (*Yoguso-minebari*).

Volle Scheibe mit Rinde.

No. der Scheibe in 1 m Höhe.	Dm. in 1 m Höhe cm.	Dick der Scheibe cm.	Länge des Sägschnitte vom Mark bis zum Umfang cm.	Distanz des Marks von Messpunkte cm.	Bezeichnung der Holzstücke.	Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	BEMERKUNGEN.
I.	26	1	12,3	9,5	Splintholz	3,00	2,91	0,09	3,0	
				6,5	Zwischenzone	3,00	2,94	0,06	2,0	
				3,0	Kernholz	3,00	2,97	0,03	1,0	
II.	26	2	12,3	9,5	Splintholz	3,00	2,90	0,10	3,3	
				6,5	Zwischenzone	3,00	2,93	0,07	2,3	
				3,6	Kernholz	3,00	2,97	0,03	1,0	
III.	26	3	12,3	9,5	Splintholz	3,00	2,90	0,10	3,3	
				6,5	Zwischenzone	3,00	2,94	0,06	2,0	
				3,0	Kernholz	3,00	2,97	0,03	1,0	
IV.	26	4	12,3	9,5	Splintholz	3,00	2,90	0,10	3,3	
				6,5	Zwischenzone	3,00	2,93	6,07	2,3	
				3,0	Kernholz	3,00	2,97	0,03	1,0	
V.	26	5	12,3	9,5	Splintholz	3,00	2,89	0,11	3,6	
				6,5	Zwischenzone	3,00	2,93	0,07	2,3	
				3,0	Kernholz	3,00	2,96	0,04	1,3	

XVI. HALESIA CORYMBOSUM (*Asagara*).

Volle Scheibe mit Rinde.										BEMERKUNGEN.
No. der Scheibe in 1 m Höhe.	Dm. in 1 m Höhe cm.	Dick der Scheibe cm.	Länge des Sägschnitte vom Mark bis zum Umfang cm.	Distanz des Marks von Messpunkte cm.	Bezeichnung der Holzstücke.	Sehnenlänge vor dem Schnitte cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	
I.	21,4	1	11,5	9	Splintholz	3,00	2,91	0,09	3,0	
				6	Zwischenzone	3,00	2,95	0,05	1,6	
				3	Kernholz	3,00	2,97	0,03	1,0	
II.	21,4	2	11,5	9	Splintholz	3,00	2,91	0,09	3,0	
				6	Zwischenzone	3,00	2,95	0,05	1,6	
				3	Kernholz	3,00	2,98	0,02	0,7	
III.	21,4	3	11,5	9	Splintholz	3,00	2,90	0,10	3,3	
				6	Zwischenzone	3,00	2,95	0,05	1,6	
				3	Kernholz	3,00	2,97	0,03	1,0	
IV.	21,4	4	11,5	9	Splintholz	3,00	2,89	0,11	3,6	
				6	Zwischenzone	3,00	2,94	0,06	2,0	
				3	Kernholz	3,00	2,97	0,03	1,0	
V.	21,4	5	11,5	9	Splintholz	3,00	2,90	0,10	3,3	
				6	Zwischenzone	3,00	2,94	0,06	2,0	
				3	Kernholz	3,00	2,97	0,03	1,0	

XVII. TSUGA SIEBOLDII (*Tsuga*).

No. der Scheibe in 1 m Höhe.	Dm. in 1 m Höhe cm.	Dick der Scheibe cm.	Länge des Sägschnitts vom Mark bis zum Umfang cm.	Distanz des Marks von Messpunkte cm.	Bezeichnung der Holzstücke.	Schnenlänge vor dem Schnitte cm.	Schnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	%	BEMERKUNGEN.
Volle Scheibe mit Rinde.										
I.	25,4	1	11,2	9	Aeusserer Theil.....	3,00	2,90	0,10	3,3	
				6	Mittler Theil.....	3,00	2,95	0,05	1,6	
				3	Innerer Theil	3,00	2,99	0,01	0,3	
II.	25,4	2	11,2	9	Aeusserer Theil.....	3,00	2,91	0,09	3,0	
				6	Mittler Theil.....	3,00	2,96	0,04	1,3	
				3	Innerer Theil	3,00	2,99	0,01	0,3	
III.	25,4	3	11,2	9	Aeusserer Theil.....	3,00	2,90	0,10	3,3	
				6	Mittler Theil.....	3,00	2,95	0,05	1,6	
				3	Innerer Theil	3,00	2,99	0,01	0,3	
IV.	25,4	4	11,2	9	Aeusserer Theil.....	3,00	2,90	0,10	3,3	
				6	Mittler Theil.....	3,00	2,93	0,07	2,3	
				3	Innerer Theil	3.00	2,99	0,01	0,3	
V.	25,4	5	11,2	9	Aeusserer Theil.....	3,00	2,90	0,10	3,3	
				6	Mittler Theil.....	3,00	2,94	0,06	2,0	
				3	Innerer Theil	3,00	2,99	0,01	0,3	

XVIII. BETULA ULMIFOLIA (*Yoguso-minebari*).

No. der Scheibe.	Baumhöhe m.	Durchschnittliche Durchmesse cm.	Sehnittlänge des kerns cm.	Breite des Splintes cm.	Sehnenlänge vor dem Schnitte cm.	Splintring für sich mit Rinde. Sehnenlänge nach dem Schnitte cm.	Splintring für sich mit Rinde. Klemmungsgrösse cm.	Splintring für sich mit Rinde. %	Scheibe des Kerns für sich. Sehnenlänge nach dem Schnitte cm.	Scheibe des Kerns für sich. Klemmungsgrösse cm.	Scheibe des Kerns für sich. %	BEMERKUNGEN.
I.	1	26,0	6,7	4,2	3,00	2,90	0,10	3,3	2,86	0,14	4,6	2,97	0,03	1,0	
II.	2	21,5	4,7	3,7	3,00	2,92	0,08	2,6	2,89	0,11	3,6	2,97	0,03	1,0	
III.	3	20,5	5,1	3,2	3,00	2,92	0,08	2,6	2,88	0,12	4,0	2,97	0,03	1,0	

XIX. HALESIA CORYMBOSUM (*Asagara*).

	No. der Scheibe.	I.	II.	III.
	Baumhöhe m.	1	2	3
	Durchschnittliche Durchmesser cm.	20,8	20,6	21,0
	Sehnittlänge des kerns cm.	6,1	6,1	6,6
	Breite des Splintes cm.	3,8	2,6	2,7
	Sehnenlänge vor dem Schnitte cm.	3,00	3,00	3,00
Splintring für sich mit Rinde.	Sehnenlänge nach dem Schnitte cm.	2,90	2,89	2,90
	Klemmungsgrösse cm.	0,10	0,11	0,10
	%	3,3	3,6	3,3
Splintring für sich ohne Rinde.	Sehnenlänge nach dem Schnitte cm.	2,90	2,89	2,90
	Klemmungsgrösse cm.	0,10	0,11	0,10
	%	3,3	3,6	3,3
Scheibe des Kerns für sich.	Sehnittlänge nach dem Schnitte cm.	2,96	2,97	2,97
	Klemmnngsgrösse cm.	0,04	0,03	0,03
	%	1,3	1,0	1,0
	BEMERKUNGEN.			

XX.

HOLZARTEN.	Durchschnittliche Durchmesser cm.	Sehnenlänge vor dem Schnitte cm.	S. (eines einzigen Sägchnitts).		N.		W.		S.		O.		BEMERKUNGEN.
			Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	Sehnenlänge nach dem Schnitte cm.	Klemmungsgrösse cm.	
Inubuna	24,6	3,00	2,90	0,10	3,00	0,00	2,99	0,01	2,95	0,05	2,95	0,05	
Momiji	27,5	3,00	2,94	0,06	3,00	0,00	2,98	0,02	2,97	0,03	3,00	0,00	
Yogusominebari ..	21,5	3,00	2,95	0,05	3,01	−0,01	2,99	0,01	2,98	0,02	2,98	0,02	
Asagara	21,0	3,00	2,96	0,04	3,01	−0,01	2,98	0,02	2,99	0,01	2,99	0,01	
Tsuga	23,1	3,00	2,97	0,03	3,00	0,00	3,00	0,00	2,99	0,01	2,98	0,02	

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Ertragstafel und Zuwachsgesetz

für

Sugi (*Cryptomeria japonica*).

Zum Gebrauch für die japanischen Forstmänner.

VON

S. Honda, *Ringakushi et Dr. Oec. publ.*

A. O. Professor für Forstwissenschaft an der Kaiserlichen Universität zu Tokyo.

VORWORT.

Die Ertragstafel bildet für die Forstwirtschaft dasselbe, was der Compass für die Schifffahrt, ein Instrument, ohne das ein zielbewusstes Handeln undenkbar ist, und einen "Betriebsplan" erst ermöglicht. Während man nun in Europa, Dank der Arbeiten der forstlichen Versuchsstationen, zahlreiche Ertragstafeln besitzt, fehlen solche bis jetzt noch in Japan mit seinen eigenartigen Wäldern und anders beschaffenen Zuwachsverhältnissen, ein Mangel, der sich in praktischer wie wissenschaftlicher Hinsicht in höchstem Grade fühlbar machte. Diese Lücke beabsichtigte ich seit längerer Zeit auszufüllen, da sie mir um so fühlbarer geworden war, als ich die Waldung des *Kiyosumi* als Schulwaldung zu bewirthschaften habe.

In den Winterferien des letzten Jahres fand ich endlich Gelegenheit, als ich mit meinen Schülern, 24 an der Zahl, eine drei Wochen dauernde Excursion in jenem Waldgebiet unternahm, die Zuwachsverhältnisse der *Cryptomeria japonica* näher zu studiren, und so eine Ertragstafel für diese wichtigste der japanischen Nutzhölzer aufzustellen.

In den beifolgenden Tafeln sind die Resultate dieser Arbeit niedergelegt, welche freilich durchaus noch als unvollständig angesehen werden muss. Indessen bin ich eifrigst damit beschäftigt, weiteres Material zu sammeln und die Ertragstafeln so zu gestalten, dass sie wohl allen Anforderungen genügen dürften.

Im zweiten Teile dieser Arbeit habe ich das Zuwachsgesetz und- gang der *Sugi*bestände in *Kiyosumi* mit denen der deutschen

Holzarten verglichen, da eine solche Vergleichung in Japan noch nicht ausgeführt worden ist.

Es sei schliesslich bemerkt, dass diese Abhandlung hauptsächlich für die japanischen Forstleute bestimmt ist, welche zum grössten Theile der deutschen Sprache mächtig sind. Ich hoffe, dass sie durch dieselbe veranlasst werden, auch ihrerseits Zuwachsverhältnisse anderer Nutzhölzer unter anderen örtlichen Verhältnissen näher zu studiren, und so zu Aufstellungen von Ertragstafeln für die japanischen Nutzwälder beizutragen.

I. TEIL.

Ertragstafeln für Sugi.

I. Einleitung.

Für eine geordnete Forstwirthschaft ist die Herstellung von Ertragstafeln die erste Bedingung. Diese Tafeln sind die quantitative Darstellung des Wachsthumsganges normal entwickelter und bestockter Bestände für verschiedene Holzarten, Standorte und Betriebsformen. Sie geben Aufschluss entweder lediglich über die Holzmassen- und Zuwachsgrössen, oder auch weiter über Bestandeshöhe, Stammzahl und Stammgrundfläche u. s. f. pro Hectar für die Bestandesentwicklung in verschiedenem Alter.

Es giebt mehrere Wege, Ertragstafeln herzustellen. Doch scheinen mir nur folgende drei Methoden wissenschaftliche Berücksichtigung zu verdienen :

1. Die erste nahliegende Methode ist, bei einem Bestande von ganz jungem Alter, wiederholt, entweder jährlich oder periodisch eine Bestandesaufnahme vorzunehmen und sämmtliche wichtige Factoren bis zu dessen Haubarkeitsalter fortgesetzt zu beachten. Insbesondere wird der Einfluss verschiedener Erziehungs- und Betriebsweisen auf den Zuwachsgang der Bestände nur durch solche genaue Controlle mehrerer verschieden behandelter Bestände *ceteris paribus* mit Sicherheit beobachtet werden können, und diese Methode ist daher auch in Deutschland bei der Zuwachsermittlung durch Einführung bestimmter Versuchsflächen allgemein acceptirt.

2. Um den sonst allzulangen Zeitraum abzukürzen, kann man auch mehrere Bestände verschiedenen Alters gleichzeitig in Beobachtung ziehen. Man erhält so einzelne Stücke jener Kurve, welche die Holzmassenzunahme eines Bestandes während der ganzen Umtriebszeit darstellen würde, welche Stücke vielleicht oft nicht genau an einander passen, aber doch, wenn z. B. Bestände von je ungefähr 20 jährigen Altersabstufungen gewählt wurden, nach Verlauf von 20 Jahren ermöglichen würden, die Holzmassen- bezw. Zuwachscurven genauer festzustellen, als dies nach der bisherigen Methode möglich war. Dabei ist es zweckmässig, mehrere Bestände von derselben Alterstufe zu beobachten, um etwaige Verschiedenheiten auszugleichen.

3. Durch diese beiden Verfahren wird der Zuwachs der Bestände direkt ermittelt; man kann aber auch aus der einmaligen Aufnahme mehrerer Bestände verschiedenen Alters eine Reihe der Bestandesmassen für alle Alterstufen erhalten und so den Gang der Massenzunahme ableiten.

Ich habe bei meinen Beobachtungen die letzte Methode gewählt, um in möglichst kurzer Zeit zu Resultaten zu gelangen.

Hinsichtlich der Literatur wurden hauptsächlich folgende Werke benutzt:

Holzmesskunde, von Prof. Dr. *Guttenberg* in *Lory's* Handbuch der Forstwissenschaft.

Holzmesskunde, von Prof, Dr. *Baur*.

Die Fichte, von Prof. Dr. *Baur*.

Ertragstafeln für die Kiefer, von Prof. Dr. *Weise*.

Holzzuwachslehre in Forsteinrichtung, von Prof. Dr. *Weber*.

II. Allgemeine Beschreibung der Standorts- und Bewirthschaftungsverhältnisse.

Der *Kiyosumi*wald, in welchem wir diese Untersuchungen anstellten, liegt in Mitteljapan, ungefähr 70 Kilometer südöstlich von Tōkyō entfernt, an den Ausläufern des Grenzgebirges zwischen den Provinzen *Awa* und *Kadsusa* bei 35° 8′ N. B. und 140° 10′ Oe. L. von Greenwich. Hydrographisch bildet jener Theil die Wasserscheide zwischen "Amatsugawa" und "Obitsugawa." Die grösste Anhöhe der Gegend ist der 382 meter

hohe *Myokōsan*, welcher rings von *Kiyosumi*wald umgeben ist und von dem aus viele kleine Höhenzüge nach allen Himmelsrichtungen auslaufen; diese schliessen vielfach mit ihren steilen Wänden tiefe Thäler ein, welche meist mit Wald bedeckt sind.

Der *Kiyosumi*wald misst von Süden nach Norden circa 3,2 und von Westen nach Osten circa 2,6 Kilometer. Der Wald grenzt im Westen an den 1700 ha grossen "Staatswald zu Okusan," nördlich an den 4600 ha grossen "Staatswald zu Tsutsumori," gegen Süden und Osten wird er vom stillen Ocean bespült. Bisher gehörte jener *Kiyosumi*wald als Staatswald zum Forstamt *Ōtaki*, noch früher aber zum Klostergute *Seichōji*. Seit einem Jahre ist derselbe in einer Ausdehnung von 336,4 ha als Schulwald der Kaiserlichen Universität Tōkyō zugewiesen worden und dient dem forstlichen Studium und Experimenten. Andererseits soll er auch ein Muster moderner systematischer Forstwirtschaft repräsentiren.

Der Untergrund besteht aus Tuff und tertiärem Sandstein. Der Boden ist im Allgemeinen sehr durchlässig, allein der mit Wald bedeckte Theil weist eine reiche circa 10 cm. tiefe Humusschichte auf, welche den Boden frisch erhält.

Der höchste Punkt der oberen Grenze liegt bei circa 350 m.; der unterste bei circa 50 m. über der Meeresfläche.

Das Localklima ist sehr mild. Die durchschnittliche Jahrestemperatur beträgt circa 15,5°, die niedrigste Temperatur circa 2°, die höchste 32° C; die Luft ist sehr feucht, wegen des Südwindes, der über den warmen Kuroshiwostrom heraufstreicht. Die Jahresregenmenge beträgt ungefähr 2000 mm. Der meiste Regen fällt im April, Juni und Juli; Schnee fällt selten, oft einen ganzen Winter hindurch gar nicht.

In früherer Zeit soll in dieser Gegend ein gemischter Wald von immergrünen Eichenarten (Quercus acuta, Quercus glauca, Quercus cuspidata u. s. w.), Tannen und Thugen vorherschend gewesen sein. Da die Benutzung der genannten Holzarten, wegen schwieriger Abfuhr fast ganz unterblieb, so musste nach und nach mit der künstlichen Pflanzung des mehr werthvollen *Sugi* vorgegangen werden, so dass jetzt der vorherrschende *Sugi*bestand nur mit einigen Tannen untermischt ist.

Die gegenwärtig angenommene Umtriebszeit ist jene von 100 Jahren. Die Betriebsart ist ein Hochwaldbetrieb wobei

der Kahlschlagbetrieb mit künstlicher Pflanzung die Regel bildet.

Die jetzt vorhandenen *Sugi*bestände sind ganz durch künstliche Pflanzung entstanden; Die Einsetzlinge waren 3 Jahre alte 2 mal verschulte circa halb Meter lange Pflanzen. Die Pflanzenzahl pro ha betrug dabei 6000 im Reihenverbande. Nach der Pflanzung haute man jährlich ein oder zweimal das ganze Unkraut ab; aber vom 5*ten* oder 7*ten* Jahre nach der Pflanzung an kamen keine Arbeiter mehr in den Wald bis nach der Haubarzeit. Nach altem Gebrauch der dortigen Gegend wurde nicht durchforstet, stärkere Bäume wachsen äusserst schnell, den schwächeren nur eine kärgliche Existenz gewährend. Die Holzbestände haben jetzt meist 10–100 jähriges Alter.

III. Darlegung des bei den Bestandesuntersuchungen beobachteten Verfahrens.

A. *Auswahl und Aufnahme der Probeflächen.*

In möglichst gleichmässiger Verteilung durch alle Alter wurde eine möglichst grosse Anzahl normal bestockter und in jeder Beziehung geeignet scheinender Probeflächen von mindestens $\frac{1}{4}$ ha Flächengrösse ausgewählt und zwar Bestände der besten und schlechtesten Standortgüte. Dieses gelang uns bei der provisorischen Bonitirung nach dem Augenmaase unter Zuhülfenahme der Höhen. Sogern man auch alle Probeflächen einen Hectar gross genommen hätte, so war dieses doch nicht möglich, weil die Bestände selten sind, in welchen man in allen Teilen ganz normal bestockte Flächen von 1 ha Flächeninhalt finden konnte.

Unser Plan war ferner, zuerst von 10 zu 10 bis 100 Jahren je 8 Probeflächen und zwar je vier für die besten Bonitäten als auch für die schlechtesten auszuwählen. Da das nicht vollständig möglich war, weil wir in dem dortigen Waldgebiete nicht genügende passende Bestände vorfanden, so mussten wir mit nur 56 Probeflächen, statt 80, einstweilen zufrieden sein, und schliesslich 15 Probeflächen aus einem Privatwalde in der Umgebung unserer Schulwaldung zu Hülfe nehmen.

Jede Probefläche wurde mit dem Pantometer gemessen, weil sie hier zu uneben war, um die Winkelspiegel zu benutzen. Die Flächenform nahm ich möglichst viereckig, zuweilen aber fünf- oder sechseckig.

Die Auswahl der Probeflächen geschah gemeinschaftlich, wobei sich die Abiturienten unseres Forstinstituts betheiligten. Obgleich wir nach einem bestimmten Arbeitsplan arbeiteten, so revidirten wir doch immer die fertiggestellten Probeflächen, um Gewissheit darüber zu haben, ob auch alle Arbeiten correct ausgeführt waren.

Die Aufnahmen der einzelnen ausgewählten Probeflächen geschah nach dem *R. Hartig'schen* Verfahren, bei welchem Probe-Stämme gefällt werden, weil wir dieses für das richtigste hielten. Die Durchmesser der sämmtlichen Stämme der Versuchsflächen wurden in 1.3 m. Höhe vom Boden in Abstufungen von 1 cm. zu 1 cm. kreuzweise genau gemessen. Die Messhöhe nahmen wir immer an der Baumaxe, das heisst bei einem Bergabhang nicht von oben und nicht von unten gemessen, sondern in der Mitte von beiden.

Je 3 Probestämme wurden von jeder Probefläche ausgewählt, welche in der Höhe von 0,3 m. vom Boden gefällt wurden. Der verbliebene Baumstock wurde in seiner Mittelstärke (also bei 0,15 m. von Boden) dreifach kreuzweise gemessen, um später die Stockholzmasse berechnen zu können. Die gefällten Probestämme wurden erst 1 m. lang vom Abhieb, dann in je 2 m. langen Sectionen, deren mittlerer Durchmesser bis auf Millimeter genau doppelt über's Kreuz abgegriffen wurden, kubirt, das Astholz jedes Probestammes anfänglich gewogen und xylometrisch kubirt und erst nachdem die Verhältnisszahl zwischen Gewicht und Volumen festgestellt war, erfolgte die Kubirung nur noch mittelst Wägung.

Zur Darlegung der Bestandesaufnahme führe ich folgendes Beispiel an:

Probefläche No. 42.

Schulwald zu *Kiyosumi*; Ortsname: *Ippaimidzu*; Abth: I; Unterabth: C; Meereshöhe: 250 m.

Die Probefläche-Aufnahme vom 2 bis 10 December 1894 geschah durch die Herrn *Horimoto*, *Mimura*, *Okuda*, und *Matsudaira*;

BERECHNUNG DER PROBEFLÄCHE Nr. 42.

Stammklasse.	Durchmesser bei 1,3 m. von Boden in cm.	Stammzahl.	Grundflächen-summe in qm.	Berechnet.	Wirklich.	Massenberechnung.	Bemerkungen.
	15	4	0,0707				
	16	1	0,0201	$g=\frac{8,3984}{133}$	$d=29,0$ cm.	$M=\frac{8,3984}{0,066052}\times 9237$	Jahrringszahl : 70
	17	6	0,1362	$=0,06314$ qm.	$g=0,066052$ qm.	$=117,4463$ fm.	
	18	1	0,0254				Alter : 70+2
	19	7	0,1985		$m=0,9237$ fm.	$A=\frac{8,3984}{0,066052}\times 0,5712$	
	20	1	0,0314	$d=28,4$ cm.		$=7,2628$ fm.	Letzte 5 jährige Triebslänge : 79 cm.
	21	4	0,1385		$a=0,05712$ fm.		
	22	5	0,1901				
	23	5	0,2077		$h=26,3$ m.		
	24	7	0,3167				
	25	7	0,3436				
I	26	2	0,1062				
	27	7	0,4008				
	28	6	0,3695				
	29	16	1,0568				
	30	5	0,3534				
	31	10	0,7548				
	32	4	0,3217				
	33	8	0,6842				
	34	7	0,6355				
	35	5	0,4811				
	36	10	1,0179				
	37	5	0,5376				
	Sa.	133	8,3984				
	37	3	0,3226				
	38	12	1,3609	$g=\frac{8,2841}{62}$	$d=41,5$ cm.	$M=\frac{8,2841}{0,1353}\times 1,7829$	Jahrringe : 70
	39	11	1,3140	$=0,13361$	$g=0,1353$ qm.	$=109,1628$ fm.	
	40	3	0,3770				Alter : 70+2
	41	7	0,9242	$d=41,2$ cm.	$m=1,7817$ fm.	$A=\frac{8,2841}{0,1353}\times 0,1170$	
	42	4	0,5542		$a=0,1170$ fm.	$=7,1546$ fm.	Letzte 5 jährige Triebslänge : 100 cm.
II	43	7	1,0165				
	44	2	0,3041		$h=26,3$ m.		
	45	8	1,2723				
	46	4	0,6648				
	47	1	0,1735				
	Sa.	62	8,2841				
	47	1	0,1735				
	48	4	0,7238	$g=\frac{8,3577}{37}$	$d=53,6$ cm.	$M=3,2600\times 37$	Jahrringe : 70
	49	6	1,1314	$=0,22588$		$=120,6200$ fm.	
	51	2	0,4036		$m=3,2600$ fm.		Alter : 70+2
	52	2	0,4247	$g=53,6$ cm.		$A=0,22556\times 37$	
	53	6	1,3237		$a=0,22556$ fm.	$=8,3462$ fm.	Letzte 5 jährige Triebslänge : 85 cm.
	54	3	0,6871				
	55	1	0,2376		$h=31,4$ m.		
III	56	2	0,4926				
	57	2	0,5104				
	58	2	0,5284				
	59	2	0,5468				
	60	1	0,2827				
	61	2	0,5845				
	62	1	0,3019				
	Sa.	37	8,3577				
Sa.		232	25,0402			$M=347,2291$ fm. $A=22,7630$ fm.	

a, A = Astholzmasse ; m, M = Schaftholz.

Bestandsgrösse: 1 ha.

Probeflächengrösse: 0,2866 ha.

Der Grund besteht aus lockerem Sandstein; Die Bodenfläche ist nach Südosten um 30° geneigt und ziemlich trocken. Bestandsschluss: gedrängt.

Der Bestand wurde von jedem Kenner als einer der besten erklärt.

Hieraus ergeben sich pro ha folgende Verhältnisse:

Alter, das Mittel aus den mittlern Altern der Klassen sowohl, wie aus den Massenaltern: 72 Jahre.

Baumhöhe: oberere 31,5 m. mittlere 28,6.

Baumstärke: stärkste 63,0 cm. schwächste 15,0 cm. mittlere 37,0 cm.

Stammzahl: 810

Holzmasse: Schaftholz = 1211,55 fm.
Astholz = 79,426 „
im ganzen = 1290,976 „

Stammgrundflächensumme: 87,376 qm.

Grünes specifisches Waldgewicht des Schaftholzes im Durchschnitt 0,734.

B. *Ergebnisse der Bestandesaufnahmen.*

Da die *Sugi* meist nur auf guten Boden gepflanzt wird, so war es sehr schwierig gewesen, viele schlechtere Bestände zu finden. Bei unserer Untersuchung hatten wir neben 32 Probeflächen bester Güte nur 24 Probeflächen geingerer Güte, unter denen allerdings auch solche mittlerer Güte vorhanden waren. Wir lassen nun das gewonnene Resultat tabellarisch folgen (Tab. 1).

IV. Konstruktion der Ertragstafeln.

a. *Entwurf der Holzmassen oder Zuwachscurven.*

Nach der Aufnahme sämmtlicher Versuchsflächen im Walde und Ausführung der zugehörigen Berechnungen schritten wir zur Konstruktion der Holzmassencurven, wobei Schaftholz allein oder Schaft- und Astholz zusammen zu betrachten ist.

Zu diesem Behufe wurde auf ein 70 cm. breites und 110 cm. langes Blatt Millimeterpapier eine horizontal gezogene Linie (Abszisse) in 110 gleiche Teile geteilt, weil der aufgenommene älteste Bestand nur 108 Jahre zählte. Auf den einzelnen Teilungspunkten dieser Linie, welche die Bestandesalter darstellen, wurden Senkrechte (Ordinaten) errichtet, auf diese die in den einzelnen Versuchsflächen gefundenen wirklichen Bestandes-Massen in einem Massstab "1 fm. zu $\frac{1}{2}$ mm" aufgetragen und die Enden der Ordinaten mit kleinen Punkten versehen. Wir erhielten so auf dem Papier, so viel Punkte, als Versuchsflächen aufgenommen wurden; denn keine zwei Punkte deckten sich vollkommen. Die einzelnen, die Masse im jugendlichen Alter darstellenden Punkte standen natürlich näher bei einander und entfernten sich mit wachsendem Bestandesalter von links nach rechts aufsteigend strahlenförmig immer mehr, weil in jüngeren Beständen die Massen resp. Massendifferenzen zwischen den besten und schlechtesten Standorten wesentlich geringer, als in älteren Beständen von 70 oder 80 und mehr Jahren der Fall ist.

Um nun bei Ausscheidung von vier Bonitäten die vier Massencurven zu erhalten, zogen wir zunächst vom Jahre Null ausgehend, durch die höchsten und ebenso durch die niedrigsten aufgetragenen Punkte, oder möglichst nahe an denselben vorüber, aus freier Hand je eine Linie, wobei kleinere Unregelmässigkeiten, wie sie bei durchschnittlich zu grossen oder kleinen Massen vorkamen, unberücksichtigt blieben. Aus diesem Grunde konnte auch die obere und untere Linie nicht alle Punkte mit einem Curvenzug durchsetzen. Die obere Linie stellt dann ungefähr die obere Grenze, die untere Linie die untere, der in verschiedenen Lebensaltern der Bestände vorkommenden Massen dar. Die Genauigkeit dieser Mittelwerthe wird natürlich um so grösser sein, je mehr Versuchsflächen

TAB. I. ÜBERSICHT

der in den einzelnen Versuchsflächen normaler Sugibestände wirklich erhaltenen Ergebnisse. (pro. ha.)

Laufende Nummer.	ORTSNAME.	Grösse der Versuchsflächen ha.	Meershöhe in m.	Exposition und Neigung.	Bestandsalter.	Bestandshöhe.		Durchmesser.			Stammzahl.	Schaftholz.		Astholzmasse fm.	Schaft- und Astholzmasse.		Stammgrundfläche bei 1.3 m. in qm.	Durchschn. Zuwachsraum der einzelnen Bäume in qm.	Mittlere Stammgrundfläche bei 1.3 m. qm.	Verhältniss der Stammgrundfläche zur Bodenfläche.	Verhältniss der Schaftholzmasse zur Astholzmasse.	Specifisches Waldgrüngewicht.	BONITAET.
						Oberere m.	Mittlere m.	Stärkster cm.	Schwächster cm.	Mittlerer cm.		Im ganzen fm.	Durchschnittszuwachs fm.		Im ganzen fm.	Durchschnittszuwachs fm.							
1	Matsuba	0,11520	300	S.O. 30°	10	3,1	2,20	8,8	2,4	4,9	2674	19,57	1,957	17,216	36,786	3,679	5,081	3,74	0,0019	0,05	87,9	0,665	IV
2	,, ...	0,25000	400	N.O. 15°	11	7,5	5,53	10,0	3,0	6,0	5215	64,00	5,818	38,591	102,591	9,326	14,601	1,92	0,0028	0,15	60,3	0,820	I
3	Tōkansawa	0,25000	348	S.O. 29°	12	3,5	2,80	11,0	1,0	2,0	2080	11,84	0,987	5,376	17,216	1,435	0,676	4,85	0,0003	0,01	45,4	0,680	V
4	Imasumi	0,20000	350	Ebene	15	11,0	9,61	21,0	4,0	11,2	2740	136,80	9,120	59,539	196,339	13,089	27,123	3,65	0,0099	0,27	43,0	0,863	I
5	Diubei	0,28600	300	N. 5°	17	12,4	7,20	20,0	2,0	11,3	2788	92,15	5,420	53,368	145,514	8,560	27,745	3,59	0,0100	0,28	57,9	0,791	III
6	Kiridoshi	0,07420	150	E.S. 12°	17	16,0	12,00	21,0	4,0	10,9	3666	198,90	11,699	57,921	256,821	15,107	34,304	2,72	0,0094	0,34	15,5	0,852	I
7	,, ...	0,25000	200	N.O. 10°	20	15,2	11,52	19,0	5,0	12,7	3011	214,00	10,700	68,592	282,592	14,130	37,820	3,31	0,0126	0,38	32,5	0,854	I
8	Imasumi	0,19820	250	N.O. 5°	22	10,0	7,10	17,0	4,0	10,9	2472	85,18	3,872	49,745	134,925	6,133	23,239	3,96	0,0094	0,23	58,4	0,781	IV
9	Kannonminami	0,37622	270	O. 12°	25	20,5	15,94	34,0	5,0	17,2	2299	346,19	13,848	79,261	425,454	17,018	52,483	4,35	0,0228	0,52	22,9	0,850	I
10	Imasumi	0,17820	340	N. 8°	26	12,3	7,52	19,0	2,0	11,0	5612	144,55	5,560	36,811	181,361	6,975	52,396	1,78	0,0093	0,52	26,4	0,863	IV
11	Matsuba	0,38360	321	O. 34°	28	20,4	14,60	40,0	3,0	17,0	1741	267,91	9,568	41,602	309,508	11,054	40,518	5,74	0,0233	0,41	15,5	0,880	II
12	Ganninbō	0,04278	288	S.O. 32°	30	13,5	11,30	23,0	3,0	10,2	5426	312,92	10,431	129,437	442,357	14,745	45,104	1,84	0,0083	0,45	41,4	0,625	II
13	,, ...	0,08910	288	S.O. 30°	30	16,4	14,00	30,0	3,0	17,1	2330	430,95	14,400	104,319	535,269	17,842	53,657	4,29	0,0230	0,54	24,2	0,760	I
14	,, ...	0,25000	280	S. 20°	35	12,1	9,45	28,0	5,0	12,0	3470	220,00	6,286	48,123	268,123	7,661	39,126	2,88	0,0113	0,39	21,9	0,770	IV
15	Kannonminami	0,10140	273	O. 20°	36	21,0	16,30	36,0	3,0	18,4	2071	461,48	12,819	97,557	559,037	15,529	54,826	5,24	0,0263	0,54	21,1	0,686	II
16	Imasumi	0,28940	340	O. 10°	36	23,0	20,67	43,0	9,0	22,0	1921	685,60	19,044	93,722	779,322	21,648	75,704	5,21	0,0394	0,76	13,7	0,790	I
17	Banshomai	0,16800	333	O. 20°–25°	36	23,0	19,52	50,0	4,0	23,0	1547	538,03	14,940	95,736	633,766	17,605	64,442	6,46	0,0423	0,64	17,7	0,780	I
18	Tōkansawa	0,11288	280	S.O. 25°	36	14,1	12,60	35,0	4,0	16,5	2374	394,95	10,970	69,135	464,085	12,891	50,090	4,21	0,0211	0,50	17,5	0,775	III
19	Yedosili	0,14884	276	S.O. 9°	38	22,4	20,30	40,0	3,0	21,0	1841	610,04	16,062	60,360	670,400	17,642	63,585	5,43	0,0345	0,63	9,9	0,840	I
20	Banshomai	0,15442	333	O. 22°	38	20,2	18,50	34,0	3,0	19,7	2163	557,32	14,666	49,967	607,287	15,981	65,721	4,50	0,0304	0,66	17,0	0,720	II
21	Ōkudari Higashi ..	0,24937	220	S.W. 14°–30°	39	24,7	20,14	38,0	10,0	23,7	1660	749,59	19,220	98,550	848,140	21,747	73,359	6,02	0,0440	0,73	13,1	0,864	I
22	Kudagara	0,24400	200	E.N. 17°	40	20,0	11,02	27,0	10,0	17,1	1870	347,74	8,694	116,075	463,815	11,595	43,312	4,31	0,0232	0,45	3,3	0,790	IV
23	Shōbuda	0,14820	288	N.O. 3°	43	26,0	20,15	54,0	6,0	31,5	1053	697,10	16,210	107,207	804,307	18,705	81,749	9,50	0,0776	0,82	17,0	0,800	I
24	Ushimitsu	0,08016	260	O.N. 15°	45	19,0	18,02	23,0	3,0	21,3	2146	595,53	13,230	112,969	708,499	15,744	75,952	4,66	0,0355	0,75	19,0	0,790	II
25	Ōkuboana	0,14284	220	O. 39°	46	25,0	21,06	48,0	8,0	22,1	1988	797,30	17,333	134,383	931,683	20,254	76,033	5,03	0,0382	0,76	17,0	0,823	I
26	Shōbuda	0,11600	288	O.S. 6°	48	25,0	18,11	50,0	6,0	20,6	2483	639,49	13,320	68,861	708,351	14,757	62,050	4,00	0,0140	0,62	10,0	0,820	II
27	Mukōmine	0,13660	170	W. 40°	48	22,1	21,20	56,0	8,0	23,1	2218	858,23	17,464	49,322	907,549	18,907	92,734	4,51	0,0418	0,93	7,5	0,850	I
28	Sakurago	0,25576	261	O.N. 24°	51	24,4	22,86	59,0	3,0	33,4	1572	675,61	13,250	228,042	903,652	17,719	68,912	6,36	0,0877	0,69	33,0	0,780	II
29	Minamisawa	0,18240	150	OO. S. 29°–30°	51	17,0	13,80	30,0	2,0	14,8	2719	296,27	5,809	47,764	344,034	6,746	46,629	3,70	0,0017	0,47	16,2	0,840	IV
30	Imasumi	0,13840	320	N.O. 5°	53	14,8	12,30	24,0	2,0	17,0	4798	428,60	8,087	76,798	505,396	9,536	110,790	2,08	0,0231	1,11	17,8	0,792	IV
31	Banshomai	0,13566	330	O. 30°	54	25,0	23,60	46,0	5,0	31,4	1887	972,22	18,004	118,533	1090,753	20,199	90,110	5,30	0,0774	0,90	12,2	0,815	I
32	Banshoshita	0,37166	200	O. 38°	56	28,0	25,80	51,0	10,0	27,6	1512	1012,54	18,081	132,132	1144,672	20,441	89,256	6,61	0,0590	0,89	12,9	0,830	I
33	,, ...	0,21154	250	N.OO. 35°	57	28,8	25,30	57,0	13,0	32,3	967	901,05	15,808	52,738	953,788	16,733	78,500	10,52	0,0812	0,79	5,9	0,793	II
34	Gomondimukai	0,14768	320	S.O. 25°	58	22,6	21,10	42,0	4,0	23,4	1885	791,58	13,648	99,743	891,321	15,368	77,584	5,30	0,0430	0,78	13,2	0,852	II
35	Minamisawa	0,12428	180	O. 22°	59	24,8	23,80	43,0	6,0	24,5	1865	948,47	16,076	84,438	1032,908	17,507	88,079	4,38	0,0471	0,88	8,9	0,791	II
36	,, ...	0,20000	180	N. 20°	61	30,2	26,92	50,0	10,1	31,0	1121	1054,12	17,281	116,512	1170,632	19,191	84,641	8,93	0,0755	0,85	11,1	0,800	I
37	Matsuba	0,47012	300	W. 30°–40°	62	26,5	17,21	63,0	3,0	29,9	842	578,69	9,334	75,743	654,432	10,555	58,891	11,87	0,0699	0,59	13,1	0,750	IV
38	,, ...	0,10776	330	S.O. 31°	64	27,0	19,00	59,0	15,0	33,0	780	721,34	11,271	68,960	790,300	12,348	66,648	12,59	0,0855	0,67	9,6	0,750	III
39	Riumensawa	0,10400	280	N.W. 21°	64	14,6	12,05	26,0	2,0	12,0	3173	217,57	3,399	44,290	261,860	4,092	36,705	3,20	0,0116	0,37	20,0	0,730	V
40	,, ...	0,24266	280	N.W. 25°	68	17,5	15,70	48,0	4,0	19,9	2028	491,67	7,230	84,454	576,124	8,472	63,283	4,90	0,0312	0,63	17,1	0,709	IV
41	Sakurago	0,13340	220	S.O. 42°	68	19,1	17,05	46,0	6,0	22,0	2039	554,00	8,150	79,870	633,870	9,322	75,650	4,90	0,0371	0,76	14,4	0,895	IV
42	Ippaimidzu	0,28660	250	S.O. 30°	72	31,5	28,60	63,0	15,0	37,0	810	1211,55	17,064	79,426	1290,976	17,930	87,376	12,37	0,1079	0,87	6,5	0,734	I
43	Tobikoshi	0,26000	300	S.O. 18°	73	26,5	21,20	62,0	26,0	39,6	526	751,03	10,288	114,575	865,605	11,858	77,171	17,00	0,0826	0,77	15,3	0,870	III
44	Koyagao	0,29320	180	S. 7°	73	32,1	28,04	60,0	18,0	33,5	968	1105,70	15,150	67,720	1173,420	16,074	85,120	10,80	0,0879	0,85	6,1	0,713	II
45	Ushirosawa	0,15794	228	N.W. 20°	75	29,5	24,30	70,0	9,0	33,8	899	854,79	11,397	76,159	930,949	12,413	79,499	11,28	0,0897	0,79	9,0	0,740	III
46	Koyagao	0,31528	180	O. 20°	75	34,1	26,30	64,0	6,0	37,1	755	925,15	12,335	59,811	984,961	13,133	76,083	13,25	0,1008	0,76	6,5	0,874	III
47	Jizōdōbori	0,13374	250	E.N. 35°	75	26,0	20,60	42,0	8,0	24,4	1609	659,23	8,789	42,459	701,689	9,356	74,897	6,21	0,0466	0,75	6,6	0,810	IV
48	Ushirosawa	0,24610	230	W. 34°	77	32,7	29,61	59,0	17,0	36,7	832	1194,80	15,516	98,512	1293,312	16,796	87,951	12,02	0,1056	0,88	8,3	0,725	I
49	Tōkansawa	0,15620	220	S. 35°	79	26,0	20,68	50,0	9,0	24,0	1831	779,50	9,867	72,503	852,003	10,785	83,673	5,46	0,0457	0,84	9,3	0,704	III
50	Koyagao	0,13340	180	SS.O. 35°–40°	81	25,2	15,00	54,0	3,2	23,6	2068	708,21	8,743	92,314	800,524	9,883	90,258	4,80	0,0435	0,90	13,3	0,880	IV
51	Tōkansawa	0,37600	220	N.O. 42°	84	28,0	25,20	60,0	5,0	31,6	1213	1068,54	12,721	61,421	1129,961	13,452	95,366	8,25	0,0786	0,95	5,7	0,650	II
52	,, ...	0,40000	220	N.O. 25°	84	33,5	30,30	61,0	28,0	39,0	761	1246,10	14,834	93,250	1339,350	15,945	90,921	13,14	0,1195	0,91	7,5	0,670	I
53	Ippaimidzu	0,39600	320	S.O. 32°	95	28,0	19,90	67,0	3,0	25,9	1818	797,55	8,395	156,860	954,410	10,046	93,765	5,50	0,0516	0,94	19,7	0,580	IV
54	,, ...	0,50000	320	N.O. 15°	95	35,2	32,11	72,0	25,0	41,1	701	1303,00	13,715	84,126	1387,126	14,601	92,815	14,30	0,1324	0,93	6,5	0,630	I
55	,, ...	0,30000	320	S.O. 20°	99	24,2	21,10	80,2	21,0	26,1	1275	745,81	7,533	92,451	838,261	8,467	68,369	7,80	0,0536	0,68	12,4	0,750	IV
56	Tobikoshi	0,30106	300	N.W. 23°	108	31,5	25,50	74,0	26,0	48,0	399	1002,82	9,285	76,300	1079,120	9,992	71,357	25,06	0,1788	0,71	7,7	0,800	III

bester und schlechtester Standortsgüte aufgenomen wurden und je gleichmässiger sie sich über die einzelnen Altersklassen verteilen. Da die Massen einiger aufgenommener Versuchsflächen auffallend unter der unteren Grenzlinie liegen, so scheint es mir, als wenn an dem betreffenden Orte wohl noch niedrigere Werthe vorgekommen wären; es war aber nicht möglich gewesen, eine noch geringere Massenklasse, also 5 te Bonitätcurven zu konstatiren, weil in diesen Gegenden *Sugi* nur sehr selten in schlechtem Boden gepflanzt wird. Solche Ergebnisse blieben daher unberücksichtigt.

Wir wussten nun, in welchen Grenzen sich die Ertragsverhältnisse der Bestände überhaupt bewegen. Da es wünschenswerth ist, die einzelnen Bonitäten gleich weit von einander abstehen zu lassen, so theilen wir jetzt bei der graphischen Darstellung die Fläche zwischen der unteren und oberen Grenzlinie der Länge nach in vier gleiche Streifen. Die Theilungslinien laufen natürlich alle im Nullpunkt zusammen und die Streifen werden um so breiter, je mehr sie sich von dem Nullpunkt entfernen wie es auf der Pl. XVIII ersichtlich ist.

Alle Punkte, resp. Bestände, welche nun in den obersten Streifen fallen, können als zur I., solche im zweiten Streifen als zur II. etc., diejenige des untersten Streifens als zur IV. Bonität zugehörig betrachtet werden.

Wir haben zuerst bei der Bestandesaufnahme nur beste und schlechteste Bestände ausgewählt; jedoch war die Auswahl hier nicht ganz nach Wunsch, weil in der Regel die Bestände mittlerer Bonität reichlicher vertreten waren und weil auch die vorher nur nach dem Augenmaas in ihrer Bonität eingeschätzten Versuchsflächen sich theilweise bei der Construction der Massencurven noch etwas anders ergaben. Viele in die I Bonität eingeschätzte Bestände fielen nach dem Auftragen in den Streifen der II, auch viele in die IV Bonität geschätzte Bestände fielen nach dem Auftragen in den Streifen der III.

Bei den Streifen der IV zeigen sich noch einzelne Lücken, welche wir wohl später bei weiteren Untersuchungen berücksichtigen werden.

Nachdem so die Normalertragskurven konstruiert sind, so ist es leicht mittelst der Millimetermassstabes auf Pl. XVIII und XIX die jeder Bonität und jedem Bestandsalter entspre-

chende Holzmasse abzulesen und in die Ertragstafeln einzutragen.

b. *Entwurf der Höhenzuwachscurven.*

a. Die Kurve der Bestandsmittelhöhe.

Nach der Ermittelung der Ertragsverhältnisse haben wir die zu jeder Bonität gehörigen Versuchsflächen unterschieden. Mit der zur I Bonität gehörigen Mittel-Höhe construirten wir die Bestandmittelhöhencurve in der Weise wie bei den Holzmassenzuwachscurven; in gleicher Weise auch die IV Bestandes mittelhöhecurven von der zur IV Bonität gehörigen Versuchsfläche.

Wenn in sämmtlichen Versuchsflächen bei den Probestämmen auch die Höhen der Längentriebe der vorhergehenden 5 Jahre gemessen werden, so erhält man auf diese Weise auch die mittleren Bestandeshöhen vor fünf Jahren, so wie durch Anrechnen der letzten fünf Längentriebe zur gegenwärtigen Höhe auch die muthmassliche Höhe nach 5 Jahren. Auf diese Weise schliessen die einzelnen aufgetragenen Ordinaten viel enger an einander, was namentlich erwünscht ist wenn grössere Lücken in den Beobachtungen vorhanden sind.

Aus der graphischen Darstellung von der I u. IV Höhencurve ergiebt sich auf graphische Weise die II und III Höhencurve wie auf Pl. XX ersichtlich ist. Aus diesen Curven folgt mittelst Millimetermaasstabs jede Bestandsmittelhöhe zu jedem Jahre und diese wurde in die Ertragstafel eingetragen.

β. Die Curve der Bestandsoberhöhe.

Auf ganz analoge Weise fanden wir auch leicht die Bestandsoberhöhe aus wirklich gemessener Bestandsoberhöhe.

c. *Entwurf der Kreisflächencurven.*

Obgleich die Bestandeshöhe als der wichtigste Maasstab für die Beurteilung der Standortsgüte bekannt ist, so ist doch auch die Kreisflächensumme des Bestandes auf der Flächeneinheit (Hektar), bezogen auf 1,3 Meter über dem Boden, und ermittelt für alle Bestandesalter und Bonitäten, namentlich dann von Werth, wenn es sich darum handelt, die Holzmasse eines

konkreten und nicht überall normal bestockten Bestandes mit Hülfe von Ertragstafeln rasch und ohne Fällung von Probestämmen zu bestimmen. Hätte z. B. der auf seine Masse zu untersuchende konkrete Bestand nur 0,75 der Kreisflächensumme des Normalbestandes der Ertragstafel, Höhe und Alter wären aber in beiden gleich, so wird auch ersterer nur 0,75 so viel Masse pro ha als letzterer haben, d. h. die Holzmassen sind in diesem Falle proportional den Kreisflächensummen. Ausserdem ist auch für Wirthschaft und Wissenschaft die Untersuchung der Kreisflächenmehrung normaler Bestände von deren Begründung an bis zur Haubarkeit nicht uninteressant. Ich brachte daher in Pl. XXI auch die Kreisflächensumme für die einzelnen Bestandesalter und Bonitäten graphisch zur Anschauung.

Es wurde hierbei genau so wie bei Bestandshöhencurven durch Auftragen der wirklich gefundenen Kreisflächen verfahren, welche nach den Bonitäten eingeteilt waren.

d. *Entwurf der Stammzahlcurven.*

Bei Begründung eines Bestandes ist natürlich die Stammzahl pro Flächeneinheit in den ersten Jahren am grössten, aber allmälig breiten sich die einzelnen Bäume aus, die Aeste kommen näher zusammen, es entsteht ein Kampf ums Dasein, der zum Tod der schwächeren Exemplare führt. Die Stammzahl pro Flächeneinheit nimmt deshalb von Jahr zu Jahr ab. Während wir in einem angepflanzten *Sugi*-Bestand am Anfange der Umtriebszeit pro Hektar 6000 Pflanzen gezählt haben, sind am Ende derselben kaum noch 500–600 Stämme vorhanden. Es ist interessant und von praktischer Wichtigkeit, das Gesetz der Stammzahlabnahme für alle Jahre der Umtriebszeit festzustellen.

Nun wurden die Stammzahlencurven für jede einzelne Bonität aufgetragen nach Altern als Abcissen und die Stammzahlensumme als Ordinaten. Die Werthe derselben lasen wir für jedes fünfte Jahr ab und trugen sie in die Ertragstafel ein (Siehe Pl. XXII).

e. *Sonstige Bestandteile der Ertragstafeln.*

Unsere Ertragstafeln enthalten weiter noch den laufenden und durchschnittlichen Höhenzuwachs, den laufenden und

durchschnittlichen Zuwachs des Schaftholzes, sowie des Schaft- und Astholzes, Durchmesser des Bestandsmittelstammes, Bestandsformzahlen, Bestandsrichthöhen, Zuwachsprocent vorwärts und endlich den Normalvorrath und das Nutzungsprocent.

Der laufende Zuwachs ergiebt sich aus den Differenzen der zwei aufeinander folgenden Gliedern der Tafeln.

also *z.* B.	80 Jahr, Masse	1229	fm.
	85 „ „	1257	„
mithin Zuwachs für 5 Jahre		28	fm.

Wenn dann angenommen wird, dass innerhalb des Jahrfünftes der Zuwachs jährlich gleichmässig erfolgt, so würde derselbe in dem vorstehenden Beispiele pro Jahr $\frac{28}{5}=5{,}6$ fm. betragen.

Der Durchmesser des Bestandsmittelstammes wurde gefunden durch Division der Kreisflächensumme durch die Stammzahl.

Die Bestands-Formzahlen ergeben sich aus den bereits bekannten Werthen:

g Kreisflächensumme,
h Bestandsmittelhöhe,
m_1 Schaftholzmasse,
m_2 Gesammtmasse.

Die Schaftholzformzahl ist $\frac{m_1}{gh}$
Die Gesammtbestandsformzahl $\frac{m_2}{gh}$.

Die Bestandsrichthöhen kann man entweder erhalten, indem man die Höhe und die Formzahl mit einander multiplicirt oder die Masse durch die Kreisfläche derselben dividirt. Beide Wege führen zum Ziel. Die Berechnung aus h und f diente dann als Probe für die Richtigkeit, denn, sind die auf beiden Wegen erhaltenen Werthe richtig, so muss h. f.$=\frac{m}{g}$ sein.

Bei dem Zuwachsprocent ist als Capitalstock die Masse im je fünften, also 5, 10, 15 u. s. w. Jahre angesehen, als Zuwachs aber die jährliche Vermehrung des nächsten Jahrfünftes.

Haben wir also *z.* B. das Zuwachsprocent für den 30 jährigen Ort I Bonität zu berechnen, so ist die Masse im 30 Jahr=443 fm.; vom 30 zum 35 Jahre erfolgt jährlich 24,6 fm. Masse, mithin haben wir ein Zuwachsprocent

$$\frac{24{,}6\times 100}{443}=\frac{2460}{443}=5{,}555.$$

Der Normalvorrath ist nach der *Pressler*'schen Formel $n\left(a+b+c+\ldots\ldots+\frac{z}{2}\right)-\frac{z}{2}$ berechnet, wobei n die Zahl der Jahre, hier also 5 bedeutet, in a, b, c, aber die Massenangaben der Tafel für das 5, 10, 15 etc. Jahr bedeuten.

Die Formel giebt den Vorrath des Normalwaldes für das Frühjahr an. Der *Judeich*'schen Auffassung folgend ist dieser Vorrath als der eigentlich normale angesehen; die Vermehrung, welche innerhalb eines Jahres erfolgt, ist lediglich als die Verzinsung des Kapitalstockes zu betrachten. Durch die Nutzung wird sie absorbirt und das Capital stets auf seine Anfangshöhe zurückgeführt.

Für das 30 te Jahr der Bonität I berechnet sich sonach der Normalvorrath an Gesammtmasse, wie folgt:

a	=	20	fm.	Vorrath in	5	Jahre
b	=	62	„	„ „	10	„
c	=	131	„	„ „	15	„
d	=	221	„	„ „	20	„
e	=	327	„	„ „	25	„
$\frac{1}{2}f$	=	221,5	„	„ „	30	„
		Sa 982,5	fm.	Vorrath.		

Da n=5 Jahre, so ist der normale Vorrath $5\times 982{,}5-221{,}5=4691$ fm.

Diese 4691 fm. lassen jährlich eine Nutzung von 443 zu, mithin ist das Nutzungsprocent $= \frac{nz}{nv}=9{,}44\,\%$.

TAB. II. NORMAL-ERTRAGSTAFELN

ALTER.	STAMMZAHL.	Stammgrundfläche bei 1.3 m. in qm.	Durchmesser des Bestandsmittelstammes in cm.	Bestands.		Holzmasse. fm.			Bestandsformzahl.	
				Mittelhöhe m.	Oberhöhe m.	Schaft.	Ast.	Zusammen.	Schaftholz.	Gesammtmasse.
5	—	—	—	1,60	2,13	20	—	20	—	—
10	—	14,20	—	4,40	6,50	62	40	102	0,992	1,632
15	3599	26,90	9,7	7,75	10,84	131	54	185	0,628	0,887
20	3068	38,65	12,6	11,35	15,05	221	67	288	0,504	0,657
25	2640	49,24	15,4	14,41	18,25	327	79	406	0,461	0,573
30	2311	58,64	18,0	16,89	20,75	443	91	534	0,447	0,539
35	2051	66,79	20,4	18,99	22,73	566	102	668	0,446	0,527
40	1824	73,39	22,7	20,86	24,43	684	112	796	0,447	0,520
45	1621	78,74	24,9	22,51	25,95	793	120	913	0,447	0,515
50	1441	83,01	27,1	23,97	27,31	893	124	1017	0,449	0,511
55	1282	86,22	29,3	25,29	28,52	978	123	1101	0,449	0,505
60	1144	88,45	31,4	26,49	29,60	1048	118	1166	0,447	0,498
65	1027	89,95	33,4	27,54	30,58	1106	113	1219	0,446	0,492
70	932	91,03	35,3	28,49	31,48	1154	107	1261	0,445	0,486
75	857	91,77	37,0	29,33	32,30	1194	102	1296	0,444	0,481
80	799	92,29	38,4	30,06	33,07	1229	96	1325	0,443	0,478
85	756	92,68	39,5	30,71	33,79	1259	92	1349	0,442	0,474
90	724	92,95	40,4	31,31	34,47	1282	87	1369	0,441	0,468
95	703	93,15	41,1	31,84	35,09	1304	83	1387	0,440	0,467
100	690	93,31	41,5	32,34	35,67	1324	78	1402	0,439	0,464

FÜR DIE SUGI, BONITÄT I.

Bestandsrichthöhe.		Laufender Zuwachs pro Jahr.		Durchschnittszuwachs pro Jahr.		Zuwachsprocent vorwärts.		Schaftholz.		Gesammtmasse.		ALTER.
Schaftholz m.	Gesammtmasse m.	Schaftholz fm.	Gesammtmasse fm.	Schaftholz fm.	Gesammtmasse fm.	Schaftholz fm.	Gesammtmasse fm.	Normalvorrath fm.	Nutzungsprocent, in fm.	Normalvorrath fm.	Nutzungsprocent, in fm.	
—	—	4,0	4,0	4,0	4,0	42,0	82,0	40	50,0	40	50,0	5
4,4	7,2	8,4	16,4	6,2	10,2	22,2	16,3	224	27,7	304	33,6	10
4,9	6,9	13,8	16,6	8,7	12,3	13,7	11,1	672	19,5	980	18,9	15
5,7	7,5	18,0	20,6	11,1	14,4	9,6	8,2	1507	14,7	2111	13,6	20
6,6	8,3	21,2	23,6	13,1	16,2	7,1	6,3	2824	11,6	3787	10,7	25
7,6	9,1	23,2	25,6	14,8	17,8	5,6	5,0	4691	9,4	6073	8,8	30
8,5	10,0	24,6	26,8	16,2	19,1	4,2	3,8	7152	7,9	9011	7,4	35
9,3	10,8	23,6	25,6	17,1	19,9	3,2	2,9	10218	6,7	12607	6,3	40
10,1	11,6	21,8	23,4	17,6	20,3	2,5	2,3	13856	5,7	16821	5,4	45
10,8	12,2	20,0	20,8	17,9	20,3	1,9	1,7	18021	5,0	21594	4,7	50
11,4	12,8	17,0	16,8	17,8	20,0	1,4	1,2	22656	4,3	26847	4,1	55
11,8	13,2	14,0	13,0	17,5	19,4	1,1	0,9	27686	3,8	32482	3,6	60
12,3	13,6	11,6	10,6	17,0	18,8	0,9	0,7	33042	3,3	38418	3,2	65
12,7	13,8	9,6	8,4	16,5	18,0	0,7	0,6	38668	3,0	44597	2,8	70
13,0	14,1	8,0	7,0	15,9	17,3	0,6	0,4	44518	2,7	50972	2,5	75
13,3	14,4	7,0	5,8	15,4	16,6	0,5	0,4	50558	2,4	57510	2,3	80
13,6	14,6	5,6	4,8	14,8	15,9	0,4	0,3	56759	2,2	64183	2,1	85
13,8	14,7	5,0	4,0	14,2	15,2	0,3	0,3	63094	2,0	70968	1,9	90
14,0	14,9	4,4	3,6	13,7	14,6	0,3	0,2	69548	1,9	77849	1,8	95
14,2	15,0	4,0	3,0	13,2	14,0	—	—	76108	1,7	84814	1,7	100

TAB. III. NORMAL-ERTRAGSTAFELN FÜR DIE SUGI, BONITÄT II.

ALTER.	STAMMZAHL.	Stammgrundfläche bei 1.3 m. in qm.	Durchmesser des Bestandsmittelstammes in cm.	Bestands.		Holzmasse.			Bestandsformzahl.	
				Mittelhöhe m.	Oberhöhe m.	fm.			Schaftholz.	Gesammtmasse.
						Schaft.	Ast.	Zusammen.		
5	—	—	—	1,27	1,70	15	—	15	—	—
10	—	—	—	3,51	5,10	46	30	76	—	—
15	4175	21,70	8,1	6 20	8,62	96	43	139	0,714	1,033
20	3646	32,08	10,6	9,14	12,08	168	55	223	0,573	0,759
25	3197	41,59	12,9	11,76	14,87	253	66	319	0,517	0,651
30	2826	50,18	15,1	13,96	17,18	348	76	424	0,497	0,605
35	2516	57,80	17,2	15,87	19,08	451	85	536	0,492	0,585
40	2244	64,24	19,1	17,60	20,72	552	94	646	0,488	0,571
45	2005	69,30	21,0	19,14	22,20	648	101	749	0,488	0,565
50	1798	73,99	22,9	20,52	23,53	736	106	842	0,485	0,554
55	1616	77,28	24,7	21,77	24,74	814	107	921	0,484	0,547
60	1457	79,62	26,4	22,91	25,82	877	106	983	0,481	0,539
65	1321	81,27	28,0	23,93	26,82	931	104	1035	0,479	0,532
70	1208	82,48	29,5	24,85	27,73	977	101	1078	0,477	0,526
75	1115	83,34	30,9	25,63	28,57	1015	98	1113	0,475	0,521
80	1040	83,95	32,1	26,37	29,36	1047	95	1142	0,473	0,516
85	982	84,39	33,1	27,01	30,08	1074	92	1166	0,471	0,513
90	938	84,69	34,0	27,57	30,76	1097	89	1186	0,470	0,508
95	906	84,89	34,6	28,09	31,38	1117	86	1203	0,468	0,504
100	885	85,03	35,1	28,57	31,95	1135	82	1217	0,467	0,500

Bestandsrichthöhe.		Laufender Zuwachs pro Jahr.		Durchschnittszuwachs pro Jahr.		Zuwachsprocent vorwärts.		Schaftholz.		Gesammtmasse.		ALTER.
Schaftholz m.	Gesammtmasse m.	Schaftholz fm.	Gesammtmasse fm.	Schaftholz fm.	Gesammtmasse fm.	Schaftholz fm.	Gesammtmasse fm.	Normalvorrath fm.	Nutzungsprocent, in fm.	Normalvorrath fm.	Nutzungsprocent, in fm.	
—	—	3,0	3,0	3,0	3,0	41,3	81,3	30	50,0	30	50,0	5
—	—	6,2	12,2	4,6	7,6	21,7	16,6	167	27,5	227	33,5	10
4,4	6,4	10,0	12,6	6,4	9,3	15,0	12,1	497	19,3	733	19,0	15
5,2	6,9	14,4	16,8	8,4	11,2	10,1	8,6	1121	15,0	1596	14,0	20
6,1	7,7	17,0	19,2	10,1	12,8	7,5	6,6	2131	11,9	2903	11,0	25
6,9	8,4	19,0	21,0	11,6	14,1	5,9	5,3	3586	9,7	4708	9,0	30
7,8	9,3	20,6	22,4	12,9	15,3	4,5	4,1	5532	8,2	7052	7,6	35
8,6	10,1	20,2	22,0	13,8	16,2	3,5	3,2	7989	6,9	9952	6,5	40
9,3	10,8	19,2	20,6	14,4	16,6	2,7	2,5	10941	5,9	13388	5,6	45
10,0	11,4	17,6	18,6	14,7	16,8	2,1	1,9	14357	5,1	17319	4,9	50
10,5	11,9	15,6	15,8	14,8	16,7	1,5	1,4	18193	4,5	21687	4,2	55
11,0	12,3	12,6	12,4	14,6	16,4	1,2	1,1	22389	3,9	26416	3,7	60
11,5	12,7	10,8	10,4	14,3	15,9	1,0	0,8	26882	3,5	31435	3,3	65
11,9	13,1	9,2	8,6	14,0	15,4	0,8	0,6	31629	3,1	36696	2,9	70
12,2	13,4	7,6	7,0	13,5	14,8	0,6	0,5	36590	2,8	42156	2,6	75
12,5	13,6	6,4	5,8	13,1	14,3	0,5	0,4	41729	2,5	47779	2,4	80
12,7	13,9	5,4	4,8	12,6	13,7	0,4	0,3	47018	2,3	53537	2,2	85
13,0	14,0	4,6	4,0	12,2	13,2	0,4	0,3	52434	2,1	59407	2,0	90
13,1	14,2	4,0	3,4	11,8	12,7	0,3	0,2	57959	1,9	65371	1,8	95
13,3	14,3	3,6	2,8	11,4	12,2	—	—	63580	1,8	71414	1,7	100

TAB. IV. NORMAL-ERTRAGSTAFELN FÜR DIE SUGI, BONITÄT III.

ALTER.	STAMMZAHL.	Stammgrundfläche bei 1.3 m. in qm.	Durchmesser des Bestandsmittelstammes in cm.	Bestands.		Holzmasse.			Bestandsformzahl.		Bestandsrichthöhe.		Laufender Zuwachs pro Jahr.		Durchschnittszuwachs pro Jahr.		Zuwachsprocent vorwärts.		Schaftholz.		Gesammtmasse.		ALTER.
				Mittelhöhe m.	Oberhöhe m.	fm.					Schaftholz m.	Gesammtmasse m.	Schaftholz fm.	Gesammtmasse fm.	Schaftholz fm.	Gesammtmasse fm.	Schaftholz fm.	Gesammtmasse fm.	Normalvorrath fm.	Nutzungsprocent, in fm.	Normalvorrath fm.	Nutzungsprocent, in fm.	
						Schaft.	Ast.	Zusammen.	Schaftholz.	Gesammtmasse.													
5	—	—	—	0,95	1,26	9	—	9	—	—	—	—	1,8	1,8	1,8	1,8	44,4	91,1	18	50,0	18	50,0	5
10	—	—	—	2,62	3,70	29	21	50	—	—	—	—	4,0	8,2	2,9	5,0	22,8	17,6	103	28,2	145	34.5	10
15	4750	16,50	6,6	4,66	6,39	62	32	94	0,806	1,219	3,8	5,7	6,6	8,8	4,1	6,3	16,8	13,2	314	19,8	483	19,5	15
20	4224	25,52	8,8	6,93	9,10	114	42	156	0,645	0,884	4,5	6,1	10,4	12,4	5,7	7,8	11,4	9,6	728	15,7	1077	14,5	20
25	3753	33,94	10,8	9,10	11,49	179	52	231	0,584	0,747	5,3	6,8	13,0	15,0	7,2	9,2	8,4	7,3	1428	12,5	2007	11,5	25
30	3341	41,72	12,8	11,02	13,60	254	61	315	0,552	0,684	6,1	7,5	15,0	16,8	8,5	10,5	6,5	5,8	2473	10,3	3330	9,5	30
35	2980	48,82	14,5	12,75	15,43	337	69	406	0,541	0,652	6,9	8,3	16,6	18,2	9,6	11,6	5,0	4,5	3909	8,6	5087	8,0	35
40	2663	55,09	16,2	14,33	17,02	421	76	497	0,533	0,630	7,6	9,0	16,8	18,2	10,5	12,4	3,9	3,6	5762	7,3	7299	6,8	40
45	2390	60,37	18,0	15,76	18,45	503	83	586	0,529	0,616	8,3	9,7	16,4	17,8	11,2	13,0	3,1	2,8	8031	6,3	9962	5,9	45
50	2154	64,96	19,7	17,06	19,76	580	88	668	0,523	0,603	8,9	10,3	15,4	16,4	11,6	13,4	2,4	2,2	10700	5,4	13056	5,1	50
55	1950	68,34	21,2	18,24	20,95	649	91	740	0,521	0,594	9,5	10,8	13,8	14,4	11,8	13,5	1,8	1,6	13738	4,7	16540	4,5	55
60	1770	70,79	22,6	19,33	22,05	707	93	800	0,517	0,585	10,0	11,3	11,6	12,0	11,8	13,3	1,4	1,3	17099	4,1	20360	3,9	60
65	1615	72,60	24,0	20,32	23,05	757	95	852	0,513	0,577	10,4	11,7	10,0	10,4	11,6	13,1	1,1	1,0	20734	3,7	24464	3,5	65
70	1483	73,94	25,2	21,21	23,99	800	95	895	0,510	0,571	10,8	12,1	8,6	8,6	11,4	12,8	0,9	0,8	24605	3,3	28810	3,1	70
75	1373	74,91	26,4	22,00	24,85	836	95	931	0,507	0,565	11,2	12,4	7,2	7,2	11,1	12,4	0,7	0,6	28677	2,9	33357	2,8	75
80	1282	75,61	27,4	22,69	25,64	866	94	960	0,505	0,560	11,5	12,7	6,0	5,8	10,8	12,0	0,6	0,5	32917	2,6	38070	2,5	80
85	1209	76,11	28,4	23,31	26,38	891	93	984	0,502	0,555	11,7	12,9	5,0	4,8	10,5	11,6	0,5	0,4	37297	2,4	42918	2,3	85
90	1151	76,44	29,1	23,87	27,05	912	91	1003	0,500	0,549	11,9	13,1	4,2	3,8	10,1	11,1	0,4	0,3	41794	2,2	47876	2,1	90
95	1110	76,64	29,7	24,35	27,66	930	89	1019	0,498	0,546	12,1	13,3	3,6	3,2	9,8	10,7	0,3	0,3	46390	2,0	52923	1,9	95
100	1081	76,76	30,1	24,80	28,23	946	87	1033	0,497	0,543	12,3	13,5	3,2	2,8	9,5	10,3	—	—	51072	1,8	58046	1,8	100

TAB. V. NORMAL-ERTRAGSTAFELN FÜR DIE SUGI, BONITÄT IV.

ALTER.	STAMMZAHL.	Stammgrundfläche bei 1.3 m. in qm.	Durchmesser des Bestandsmittelstammes in cm	Bestands.		Holzmasse.			Bestandsformzahl.		Bestandsrichthöhe.		Laufender Zuwachs pro Jahr.		Durchschnittszuwachs pro Jahr.		Zuwachsprocent vorwärts.		Schaftholz.		Gesammtmasse.		ALTER.
				Mittelhöhe m.	Oberhöhe m.	fm.																	
						Schaft.	Ast.	Zusammen.	Schaftholz.	Gesammtmasse.	Schaftholz m.	Gesammtmasse m.	Schaftholz fm.	Gesammtmasse fm.	Schaftholz fm.	Gesammtmasse fm.	Schaftholz fm.	Gesammtmasse fm.	Normalvorrath fm.	Nutzungsprocent, in fm.	Normalvorrath fm.	Nutzungsprocent, in fm.	
5	—	—	—	0,63	0,83	4	—	4	—	—	—	—	0,8	0,8	0,8	0,8	40,0	95,0	8	50,0	8	50,0	5
10	—	—	—	1,73	2,30	12	11	23	—	—	—	—	1,6	3,8	1,2	2,3	26,7	22,6	44	27,3	66	34,8	10
15	5326	11,30	5,2	3,12	4,17	28	21	49	0,794	1,387	2,5	4,3	3,2	5,2	1,9	3,3	22,9	16,7	136	20,6	233	21,0	15
20	4802	18,95	7,1	4,72	6,13	60	30	90	0,671	1,005	3,2	4,7	6,4	8,2	3,0	4,5	15,0	11,8	340	17,6	560	16,1	20
25	4310	26,29	8,8	6,44	8,11	105	38	143	0,620	0,845	4,0	5,4	9,0	10,6	4,2	5,7	10,5	8,7	730	14,4	1116	12,8	25
30	3856	33,26	10,5	8,08	10,03	160	45	205	0,595	0,763	4,8	6,2	11,0	12,4	5,3	6,8	7,9	6,8	1365	11,7	1955	10,5	30
35	3445	39,83	12,1	9,63	11,78	223	52	275	0,581	0,716	5,6	6,9	12,6	14,0	6,4	7,9	6,0	5,3	2291	9,7	3120	8,8	35
40	3083	45,94	13,8	11,06	13,31	290	58	348	0,571	0,685	6,3	7,6	13,4	14,6	7,3	8,7	4,7	4,3	3540	8,2	4641	7,5	40
45	2774	51,43	15,4	12,38	14,70	358	64	422	0,562	0,662	7,0	8,2	13,6	14,8	8,0	9,4	3,7	3,4	5126	7,0	6529	6,5	45
50	2511	55,94	16,8	13,60	15,98	424	70	494	0,557	0,648	7,6	8,8	13,2	14,4	8,5	9,9	2,8	2,7	7048	6,0	8783	5,6	50
55	2283	59,40	18,2	14,71	17,17	484	76	560	0,554	0,639	8,1	9,4	12,0	13,2	8,8	10,2	2,2	2,1	9288	5,2	11385	4,9	55
60	2083	61,96	19,5	15,75	18,27	537	81	618	0,550	0,632	8,7	10,0	10,6	11,6	9,0	10,3	1,7	1,7	11815	4,5	14301	4,3	60
65	1909	63,92	20,7	16,71	19,29	583	86	669	0,546	0,626	9,1	10,5	9,2	10,2	9,0	10,3	1,4	1,3	14591	4,0	17493	3,8	65
70	1759	65,39	21,8	17,57	20,24	623	89	712	0,542	0,619	9,5	10,9	8,0	8,6	8,9	10,2	1,1	1,0	17586	3,5	20924	3,4	70
75	1631	66,48	22,8	18,33	21,12	657	92	749	0,539	0,614	9,9	11,3	6,8	7,4	8,8	10,0	0,9	0,8	20769	3,2	24558	3,1	75
80	1523	67,27	23,7	19,01	21,93	685	93	778	0,536	0,608	10,2	11,6	5,6	5,8	8,6	9,7	0,7	0,6	24110	2,8	28361	2,7	80
85	1435	67,82	24,5	19,61	22,67	708	93	801	0,532	0,601	10,4	11,8	4,6	4,6	8,3	9,4	0,5	0,5	27581	2,6	32297	2,5	85
90	1365	68,18	25,2	20,15	23,34	727	93	820	0,529	0,596	10,7	12,0	3,8	3,8	8,1	9,1	0,4	0,4	31159	2,3	36340	2,3	90
95	1313	68,38	25,8	20,61	23,95	743	92	835	0,527	0,592	10,9	12,2	3,2	3,0	7,8	8,8	0,4	0,3	34826	2,1	40470	2,1	95
100	1276	68,48	26,1	21,03	24,51	757	91	848	0,526	0,588	11,1	12,4	2,8	2,6	7,6	8,5	—	—	38569	2,0	44671	1,9	100

V. Gebrauch der Ertragstafeln.

Die vorstehenden Ertragstafeln enthalten unter Voraussetzung normaler Bestockung für den Hauptbestand pro Hectar und für die Bestandesalter 1–100;

a. Die Stammzahl,
b. die Stammgrundfläche bei 1.3 m. vom Boden in Quadratmetern,
c. die mittlere- und obere Bestandshöhe in Metern,
d. die Holzmasse des Schaftes und des Astes,
e. Schaft- und Astholzmasse,
f. Bestandsformzahl für die Schaftholzmasse und für die Gesammtholzmasse,
g. Bestandsrichthöhe für die Schaftholz und für die Gesammtholzmasse,
h. den laufenden Zuwachs des Schaftholzes und des Gesammtholzes,
i. den durchschnitlichen Zuwachs des Schaftholzes und des Gesammtholzes,
j. das Zuwachsprocent des Schaftholzes und des Gesammt holzes,
k. den Normalvorrath des Schaftholzes und des Gesammtholzes,
l. das Nutzungsprocent des Schaftholzes und des Gesammtholzes;

1. Sie zeigen, in welchem Verhältniss mit zunehmendem Bestandesalter die Stammzahl sich vermindert, Grundflächensumme und Höhe desselben aber wachsen, und in welcher Lebensperiode der grösste laufende jährliche und grösste durchschnittliche Flächen- und Höhenzuwachs eintritt.

2. Sie geben Aufschluss über die mit dem Bestandesalter zunehmende Massenmehrung an Schaftholz sowohl, als an Astholz, ferner über den Eintritt des Zeitpunktes, in welchem der grösste laufendjährliche und grösste durchschnittlichjährliche Massen-Zuwachs erfolgt.

3. Sie zeigen ferner, in welchem Verhältniss mit zunehmendem Bestandesalter die Zuwachsprocente, die Nutzungsprocente und der Normalvorrath der genannten Sortimente ab- oder zunehmen.

4. Sie dienen zur Bonitirung konkreter Bestände und ist vor Allem die mittlere Bestandeshöhe hierbei entscheidend und zwar wegen der grösseren Bequemlichkeit. Will man z. B. wissen, in welche Bonität ein unter mittleren Schlussverhältnissen erwachsener Bestand zu setzen ist, so ermittelt man nur dessen Alter und mittelst eines Höhenmessers dessen mittlere Scheitelhöhe. Da nach den Ertragstafeln z. B. ein 60 jähriger *Sugi*-bestand I Bonität 26,49 Meter hoch ist, so würde wenn der konkrete Bestand ebenfalls 60 jährig und dieselbe Höhe hätte, er jedenfalls der I Bonität angehören u. s. w. Ebenso wird irgend ein Bestand zwischen zwei Bonitäten fallen, wenn seine Höhe, natürlich immer gleiches Alter vorausgesetzt, zwischen beide fällt.

Es wird noch ein weit richtigeres Resultat erhalten, wenn man ausser der Höhe noch die Grundfläche ermittelt, weil beim Gebirgswalde bei gleichalterigem Bestande mit gleichen Höhen nicht immer gleiche Holzmasse produciert wird.

Die vorstehenden Ertragstafeln werden speciell bei der Einschätzung der einzelnen Bonitäten für Zwecke der Feststellung der Grundsteuer nöthig sein, wenn man bei Bodenuntersuchungen die Höhe und die Grundfläche als Haupt-Faktor der Standortgüte betrachtet.

5. Sie nützen aber auch bei Einschätzung der Holzmassen konkreter Bestände, wenn man keine umständlicheren Bestandesschätzungsmethoden in Anwendung bringen kann oder will. Besitzt z. B. der abzuschätzende Bestand eine volle normale Bestockung, so wird er auch dieselbe Holzmasse wie der gleich alte und gleich hohe Bestand in der Ertragstafel haben. Ist diese Bestockung jedoch keine vollkommene, sondern beträgt sie z. B. nur 0,8 der normalen, so muss natürlich auch die aus der Tafel herauszulesende Holzmasse durch Multiplikation mit dem Faktor 0,8 reduciert werden. Es sind nun verschiedene Fälle möglich :

a. Der Bestand entspricht genau im Alter in der Stammgrundfläche und Höhe einem Satze der Tafel. Dann gilt die dort angegebene Masse ohne weiteres.

b. Der Bestand fällt im Alter zwischen zwei Glieder der Tafel, Kreisfläche und Höhe sind aber so, dass sie den Tafelcurven (Pl. XVIII) entsprechen. Dann ist die Masse des nächsten

jüngeren Bestandes zu nehmen und so vielmal den jährlichen Zuwachs hinzuzuzählen, wie der Unterschied der Jahre beträgt z. B. ein 68 jähriger Ort mit 82,00 qm Stammgrundfläche und 24,48 m Höhe gehört genau in die Bonität II, denn diese hat für

65 Jahr 23,93 m Höhe und 81,27 qm Grundfläche
70 „ 24,85 „ „ „ 82,48 „ „

Die Masse im 65 Jahre ist 1035 fm. mithin im 68 Jahre, da der laufende Zuwachs=8,6 fm ist, $1035+3\times 8{,}6=1060{,}8$ fm.

c. Der Bestand entspricht in Alter und Grundfläche der Tafel, aber nicht in der Höhe; dann wird das angenäherte Gesetz bei der Ermittelung zu Grunde gelegt, dass die Massen den Höhen proportional sind. Es besteht also die Proportionalität:

$$m : h = m_x : h_1$$

worin m und h aus der Tafel, h_1 aber durch Messung bekannt ist; z. B. ein Bestand habe 81,27 qm Grundfläche im 65 Jahre, seine Höhe sei 23 m: Er gehört demnach in die Bonität II. Die gesuchte Masse ist daher:

$$1035 : 23{,}93 = m_x : 23 \qquad m_x = 994{,}78 \text{ fm.}$$

(m : h ist der Factor zur Höhe, den wir auf pag 364 berechnet finden. Entnehmen wir dort denselben, so haben wir h nur noch mit demselben zu multipliciren, um die Masse zu finden).

d. Wenn ein Bestand im Alter und in der Höhe, jedoch nicht in der Grundfläche gleich ist, so kann man die Masse nach dem Verhältnisse der Grundfläche berechnen. Es ist $m : g = m_x : g_1$ in welcher Proportionalität wieder m und g aus der Tafel, g_1 aber aus dem Bestande bestimmt werden muss. $m : g$ ist aber die in der Ertragstafel berechnete Richthöhe; wir brauchen demnach nur noch diese mit der Bestandsgrundfläche zu multipliciren, um den Ertrag zu erhalten; z. B. Ein 65 jähriger Bestand, welcher der Höhe nach genau II Bonität angehört, habe nur 80 qm Grundfläche, dann ist Masse=1016 fm, da die Richthöhe=12,7 m und das Produkt $80\times 12{,}7=1016$ ist.

e. Differiren in den unter *c* und *d* eben gedachten Fällen auch die Alter gegen die Tafel, so müssen diejenigen Factoren zur Höhe resp. Richthöhen genommen werden, die zu dem gefundenen Bestandsalter gehören. Ist der Bestand z. B. nicht 65 jährig, sondern 68 jährig, so wird bei abweichender Höhe (von

23 m) diese mit 43,33 zu multipliciren, mithin die Masse=996,59 fm. sein. Sie ist niedriger als vorhin, weil ein Bestand, der erst im 68. Jahre die Höhe 23 m. erreicht, einer niedrigeren Bonität angehören muss, als ein solcher, der schon im 65. Jahre diese Höhe hat.

Weicht der 68 jährige Bestand aber nicht in der Höhe von der Tafel ab, sondern nur in der Grundfläche und ist diese wie vorhin =80 qm, so ist die Masse 80×13,0=1040 fm. Hat ein Bestand nur im Alter, aber auch in diesem nicht mit der Tafel Uebereinstimung, so ist die Masse nach der Gleichung

$$M = g.\ h.\ f.$$

zu berechnen, so dass nur f aus der Tafel entnommen werden kann; man bestimme diese Grösse jedoch nicht nach dem Alter, sondern nach der Höhe, weil sie zumeist von dieser, vom Alter hingegen nicht bemerkbar abhängt. Ist z.B. in einem 65 jährigen Bestande die Grundfläche=80 qm, die Höhe=23 m, so ist die Formzahl, wie aus der Tafel für Bonität II zu entnehmen=538 daher

$$M = 80 \times 23 \times 0{,}538 = 989{,}92 \text{ fm.}$$

Einfacher ist es, wenn man f.h direct aus der Tafel entnimmt. Zur Höhe 23 m. gehört dann bei Bonität II die Richthöhe 12,3; mithin ist die Masse $80 \times 12{,}3 = 984$ fm.

6. Die vorstehenden Ertragstafeln nützen aber in noch höherem Maase bei Massenzuwachsermittlung der Bestände. Wenn man z. B. feststellen will, um wie viel Festmeter ein normal bestockter 60 jähriger *Sugi*bestand, welcher nach seiner Höhe und Grundfläche genau der II Bonität angehört, in den nächsten 15 Jahren zuwächst, so hat man nur aus der Ertragstafel II. Bonität die Holzmasse des 75 jährigen Bestandes mit 1113-fm und die des 60 jährigen Bestandes mit 983 fm. herauszuschreiben, und erhält in der Differenz beider Zahlen, nämlich in 1113–983=130 fm. den 15 jährigen Haubarkeitszuwachs pro Hektar. Fiele der fragliche Bestand, was in der Regel der Fall sein wird, hinsichtlich seiner Standortsgüte zwischen zwei Bonitäten hinein und wäre auch seine Bestockung eine abnorme, so müssten dann natürlich dieselben Reduktionen wie im vorigen Beispiel vorgenommen werden, um den konkreten Zuwachs zu erhalten.

7. Unsere Ertragstafeln sind ferner auch nöthig zur Ermittlung des Normalvorrathes aller möglichen Umtriebszeiten. Will man z. B. den Normalvorrath bei 100 jähriger Umtriebszeit für 120 Hektar haben, so braucht man nur die 100 Massenglieder der betreffenden Bonität zu addiren.

8. Endlich können die Ertragstafeln noch zur Lösung aller Fragen der Waldwerthberechnung und der forstlichen Statik verwerthet werden. Man braucht nur die in denselben stehenden Holzmassen in Sortimente zu zerlegen, letztere dann mit den zugehörigen reinen durchschnittlichen Holzpreisen zu multipliciren; dann erhält man in den Summen der einzelnen Produkte den in Geld ausgedrückten Werth des Holzes pro Hektar für jedes Bestandsalter und auch für jede Bonität.

II. TEIL.

Zuwachsgesetz von Sugibeständen.

mit besonderer Berücksichtigung der *Weber*'schen Zuwachsgesetze.

I. Holzmasse.

a. *Jährlicher Massenzuwachs.*

Ich habe, zum Vergleich der aus meinen Untersuchungen sich ergebenden Massencurve, auch die Curve in punktirten Linien beigefügt, wie sie sich aus der Formel

$$100\,p^3\left(1-\frac{1}{1{,}0\,p^x}\right)$$

berechnet, welche mein verehrter Lehrer Prof. Dr. *R. Weber* in München abgeleitet hat; in dieser Formel bedeutet p die Grundzahl, welche die Wachsthumsenergie angiebt, x das Alter (Siehe Pl. XVIII et XIX).

Aus diesen Curvendarstellungen sehen wir, dass auch die japanischen *Sugi*bestände jenem Zuwachsgesetz folgen, welches

in europäischen Waldungen Geltung hat. Unsere Massencurven ergeben folgende Angaben von p:

TAB. VI.

	Bonität.				Jugend-stadium im Jahre.
	I	II	III	IV	
Schaftholz	2,47–2,49	2,35–2,37	2,24–2,25	2,09–2,10	15
Schaft- und Astholz	2,50–2,52	2,39–2,41	2,28–2,29	2,15	15

Zum Vergleiche nehmen wir Angaben über deutsche Fichten und Weistannen aus *Weber's* Forsteinrichtung heraus, weil beide Holzarten im Zuwachsgang am meisten unseren *Sugi*beständen ähnlich sind (Tab. VII).

TAB. VII.

Bonitäten.	I	II	III	IV	V	Jugend-stadium Jahre.
	Werthe für p der Kurven.					
Fichten.						
Im Harz nach *Hartig*.. ..	2,4–2,3	2,3–2,2	—	—	—	40
In Würthenberg nach v. *Baur*	ca.2,2	ca.2,1	1,96–1,90	1,71	—	20
In Sachsen nach *Kunze* ..	2,3	2,17	2,03	1,89	—	15
In Norddeutschland nach *Schwabach*..	2,4–2,3	ca.2,2	2,1–2,0	1,9–1,8	ca.1,7	20
In Süddeutschland nach *Schwabach*..	2,4–2,3	ca.2,2	2,13–2,10	2,0–1,9	ca.1,8	20 u. 35
In Gouv. St. *Petersburg* nach de *Bedemmar*	1,9–1,8	1,80–1,74	1,64–1,63	ca.1,5	1,4–1,3	25
Weisstannen.						
In Baden nach *Schuberg* ..	2,4–2,3	2,25–2,20	2,15–2,05	2,0–1,9	ca.1,9	25 u. 40
In Württemberg nach *Lorey*.	2,5–2,4	ca.2,3	ca.2,2	—	—	50 u. 60

Aus beiden Tabellen (VI, VII) sehen wir, dass das von *Schwabach* gefundene p für Fichten am nächsten unserem *Sugi-p* kommt, nur im Jugendstadium sind grössere Unterschiede bemerklich, weil unsere *Sugi* viel rascher wächst, als deutsche Fichten.

b. *Laufender jährlicher Massenzuwachs.*

Es culminirt der laufende jährliche Zuwachs:

bei	Bonität	I	um	das	35	ste	Jahr
„	„	II	„	„	35	„	„
„	„	III	„	„	35–40	„	„
„	„	IV	„	„	45	„	„

Es geht aus diesen Zahlen hervor, dass beim Zuwachs an Gesammtmasse *der Kulminationspunkt bei besseren Standortverhältnissen früher eintritt als bei ungünstigeren*, wie sich auch aus *Weber's* Theorie[1] ergiebt.

Beim Schaftholz finden wir ebenfalls den obigen ähnliche nämlich:

für	Bonität	I	um	das	35	Jahr
„	„	II	„	„	35	„
„	„	III	„	„	40	„
„	„	IV	„	„	45	„

Nun wollen wir zum Vergleich unsere Zahlen mit den Zahlen für europäische Fichten und Weistannen in einer Tabelle folgen lassen: (Tab. VIII).

TAB. VIII.

Zeitpunkt und Massenbetrag der Kulmination des laufenden Zuwachses.

	I Bonität.		II Bonität.		III Bonität.		IV Bonität.		V. Bonität.	
	Jahr.	cbm.	Jahr.	cbm.	Jahr.	cbm.	Jahr.	cbm.	Jahr.	cbm.
Fichte.										
Nach v. *Baur*	27–30	19,2	38–39	13,0	27–46	8,0	31–50	6,0	—	—
Nach *Schwabach*										
in Norddeutschland ..	30–35	22,7	40	17,1	55	13,2	60	9,8	65	7,5
in Süddeutschland ..	40	23,2	45	16,6	60	13,1	85	10,5	80	8,0
Weisstanne.										
Nach *Schuberg*	25	22,4	40	17,2	35–40	13,5	40–50	9,2	50–80	7,05
Nach *Lorey*	80	16,0	90	12,8	95–105	10,8	—	—	—	—
Sugi in Japan ..	35	26,8	35	22,4	35–40	18,2	45	14,8	—	—

(1) *Weber's* Forsteinrichtung Seite 249.

Diese Tabelle zeigt, dass der Kulminationszeitpunkt von *Sugi* dem der deutschen Fichte und Weisstanne ziemlich nahe steht, dass aber der Massenbetrag der *Sugi* bei der Kulmination bedeutend grösser ist.

c. *Massendurchschnittszuwachs.*

Bei der Gesammtmasse ist auch die Culmination des Durchschnittszuwachses vorhanden: Sie tritt ein

für	Bonität	I	um	das	Jahr	45–50
„	„	II	„	„	„	50
„	„	III	„	„	„	55
„	„	IV	„	„	„	60–65

Die *Zeiten liegen also bei geringeren Bonitäten immer 5 Jahre später. Je geringer die Bonität, um so später tritt die Culmination ein und um so länger schiebt sich die Abnahme des Massendurchschnittzuwachses hinaus.*

Beim Schaftholz beobachten wir Culmination

für	Bonität	I	um	das	Jahr	50
„	„	II	„	„	„	55
„	„	III	„	„	„	55–60
„	„	IV	„	„	„	60–65

Auch hier gilt dasselbe Gesetz wie für die Gesammtmasse, während die absoluten Jahreszahlen immer um 5 grösser sind.

Da die Umtriebszeit für den grössten Massenertrag im Kulminationsjahre des Massendurchschnittszuwachses liegt, so kann man sagen, dass bei unseren *Sugi*waldungen der grösste Massenertrags-Umtrieb für 1 Bonität 50 Jahre beträgt und für je eine Bonitätsklasse schlechter um 5 Jahre zunimmt.

d. *Verhältniss von laufendem jährlichen- und durchschnittlichen Massenzuwachse.*

Ein Blick auf Pl. XXVI lehrt uns, dass der laufende jährliche Zuwachs sehr schnell bis zu einem Maximum ansteigt, um von da ab wieder schnell herab zu sinken, während der *Durchschnittszuwachs* viel langsamer steigt und fällt, als jener; der Culminationspunkt liegt bei ersterem viel höher, als bei letzterem.

Ausserdem sieht man, dass der Culminationspunkt des Durchschnittszuwachses immer derjenige Punkt ist, wo dessen Curve mit der Curve des laufenden jährlichen Zuwachses kreuzt.

Prof. *Weber* hat für den Durchschnittszuwachs die Formel

$$D+x=\frac{100p^3\left(1-\frac{1}{1.0p}x\right)}{i+x}$$

abgeleitet. Nach dieser Formel habe ich ebenfalls die Curve des Durchschnittszuwachses gezeichnet. Wie aus der punktirten Linie in Pl. XXVI zu ersehen, fällt diese mit dem beobachteten Durchschnittszuwachs für unsere *Sugi* annähernd zusammen.

e. *Verhältniss von Massen- und Höhenzuwachs.*

Aus diesen Verhältnissen habe ich den Factor zur Höhe berechnet und die Zahlen in Tabelle IX zusammen gestellt.

TAB. IX.

Alter.	Factoren zur Höhe in qm.			
	Bonität I.	Bonität II.	Bonität III.	Bonität IV.
5	12,50	11,81	9,47	6,35
10	23,18	21,65	19,08	13,29
15	23,87	22,42	20,17	15,70
20	25,37	24,40	22,51	19,07
25	28,17	27,13	25,38	22,20
30	31,62	30,37	28,58	25,37
35	35,17	33,77	31,84	28,56
40	38,16	36,70	34,68	31,46
45	40,56	39,13	37,18	34,09
50	42,43	41,03	39,16	36,32
55	43,53	42,31	40,57	38,07
60	44,02	42,91	41,39	39,24
65	44,26	43,25	41,93	40,04
70	44,26	43,38	42,19	40,52
75	44,18	43,43	42,32	40,86
80	44,07	43,31	42,31	40,93
85	43,93	43,17	42,21	40,85
90	43,72	43,02	42,02	40,69
95	43,62	42,83	41,85	40,51
100	43,35	42,59	41,65	40,32

Hieraus erfahren wir, dass die Höhenzunahme so ziemlich denselben Gesetzen gehorcht, wie die Massenzunahme, dass sich jedoch kleine Unterschiede zeigen. Es besteht nur aproximativ die Proportionalität der Massen mit den Höhen; auch ist der Factor zur Höhe für ein und dieselbe Tafel nicht immer constant, sondern veränderlich, was Herr *Weise* zuerst in seinen Kiefer-ertragstafeln erwähnt hat.

II. Bestandsmittelhöhen.

Prof. Dr. *Weber* hat die Höhe h_a bei dem Alter a mit dem Grenzwerth h_{max} algebraisch durch die Formel:

$$h_a = h_{max}\left(1 - \frac{1}{1{,}0px}\right)$$ verbunden.

Nach dieser Formel habe ich die Resultate meiner Untersuchungen über die Bestandsmittelhöhe berechnet und zur graphischen Darstellung gebracht. Die stark gezogenen Linien in Pl. XX zeigen diesen Wachsthumsgang, daneben wurden die Kurven punktirt aufgetragen, welche man bekommt, wenn man in der Formel den bestimmten Grenzwerth von h_{max} mit 35 m einsetzt.

Diese Ergebnisse zeigen deutlich dass der Zuwachsgang der Bestandsmittelhöhe bei der *Sugi* auch dem der deutschen Holzarten[1] sehr ähnlich ist und dass *die Höhenwachsthumsenergie mit zunehmender Bodengüte grösser wird*, (siehe Tabelle X).

TAB. X.

	I Bonität.	II Bonität.	III Bonität.	IV Bonität.	V Bonität.
	P der Bestandmittelhöhe.				
Sugi in Japan	2,75	1,8–2,0	1,3–1,5	1,1–1,2	—
Kiefer, Fichte, Buche und Tanne in Deutschland.	2–2,5	1,5–2	«	1–0,7	0,5

(1) *Weber's* Forsteinrichtung Seite 157.

Die absolute Grösse von p ist für *Sugi* etwas grösser, als für deutsche Hölzer; während des Jugendstadiums von *Sugi* aber ist sie viel geringer als für deutsche Hölzer (mit Ausnahme der Kiefer): Kiefer 5 Jahre
Fichte 10 „
Buche 15 „
Tanne 15–25 „
Sugi 5 „

Der laufende Höhenzuwachs culminirt bei

Bonität I mit 11,35 m zum 20 Jahre (die Masse 35 Jahre)
„ II „ 9,14 „ „ 20 „ („ „ 35 „)
„ III „ 6,93 „ „ 20 „ („ „ 35–40 „)
„ IV „ 6,44 „ „ 25 „ („ „ 45 „)

Es zeigt diese Tabelle, dass *der Höhenzuwachs der Sugi beträchtlich früher kulminirt als der Massenzuwachs, und zwar auf besseren Standorten etwas früher als auf geringeren.*

Die durchschnittliche jährliche Zunahme der Höhe culminirt bei Bonität I und II um das Jahr 25, während bei schlechten Bonitäten etwas später, nämlich bei III um das 30, bei IV um das 40.

Um Wachsthumsgänge des Laufend- und Durchschnittszuwachses der Bestandsmittelhöhe zu veranschaulichen, habe ich sie in Pl. XXV. graphisch zusammen gestellt.

III. Stammzahlen.

Wir finden hier zunächst, dass die Stammzahl mit steigender Bodengüte in gleichem Alter fällt:

Jahr	20	30	40	50	60	70	80	90	100
Bonität I	3068	2311	1824	1441	1144	932	799	724	690
„ II	3646	2826	2244	1798	1457	1208	1040	938	885
„ III	4224	3341	2663	2154	1770	1483	1282	1151	1081
„ IV	4802	3856	3083	2511	2083	1759	1523	1365	1276

Nun vergleichen wir unsere Stammzahl von *Sugi* mit europäischen Holzarten:

TAB. XI.

Die Stammzahl des Hauptbestandes auf 1 ha normaler Waldfläche:

Bonität.	I	II	III	IV	V	I	II	III	IV	V
Holzarten, Wuchsgebiet.	Beim 40 jährigen Alter.					Beim 100 jährigen Alter.				
Sugi in Japan	1824	2244	2663	3083	—	690	885	1081	1276	—
Fichte.										
Württemberg nach v. *Baur*	2632	4000	—	—	—	600	744	—	—	—
Sachsen nach *Kunze*..	2420	3150	4900	8800	—	630	730	1050	—	—
Harz nach *R. Hartig*	2936	3916	—	—	—	572	792	—	—	—
Mitteldeutsches Gebirge und Norddeutschland nach *Schwäbach* ..	2800	3370	4810	6760	9800	550	715	950	1250	1600
Süddeutschland n. *Schwabach*.. ..	2380	4070	6030	7910	11000	555	660	805	935	1200
Gouvernement St. *Petersburg* nach *Wargas* de *Bedemmar*	2460	3080	3530	4520	5770	656	765	886	1050	1370
Weisstanne.										
Württemberg nach *Lorey*	3220	5700	—	—	—	528	775	1100	—	—
Baden nach *Schuberg*	3053	3947	5080	6643	—	569	621	750	942	—
Kiefer.										
Preussen, Bayern und Sachsen nach *Weise*	1816	2558	3054	3909	4535	426	461	568	—	—
Hessische Main-Rhein-Ebene nach *Schwabach*	2380	3130	3500	5070	—	350	525	—	—	—
Hessisches Buntstein-Gebiet nach *Schwabach*	2490	3130	3630	3970	—	650	710	—	—	—
Norddeutsche Tiefebene nach *Schwabach*	1740	2370	3070	3980	5640	448	525	638	815	1070
Pommern uach *R. Hartig*	1566	—	—	—	—	423	—	—	—	—
Württemberg nach *Speidel*	2050	2770	1430	—	—	700	790	—	—	—
Gouvernement St. *Petersburg* nach *Wargas* de *Bedemmar*	3060	3520	3980	4590	5280	624	799	908	1115	1420

Aus dieser Tabelle ersehen wir, dass unsere Stammzahl von *Sugi* beim 100 jährigen Alter immer grösser ist, als die von europäischen Holzarten, während bei 40 jährigem Alter im allgemeinen diejenige für *Sugi* kleiner ist als die der europäischen Bäume; d. f. die Stammzahl für Sugi vermindert sich langsamer, als die von europäischen Holzarten. Diese Thatsache versteht man indessen leicht, wenn man sich das japanische günstige warm-feuchte Klima vergegenwärtigt.

Betrachtet man den Verminderungsgang der Stammzahlen für *Sugi* mittelst der *Weberschen* Formel für die Stammzahlverminderung:

$$\frac{10000}{1{,}0\,p^x}$$

so findet man, dass diese Formel für *Sugi* in *Kiyosumi* zu schnell abnimmt und daher unbrauchbar ist. Wenn man aber statt $1{,}0\,p^x$ $1{,}0\,p^{\frac{x}{2}}$ für *Sugi* benutzt, welcher Ausdruck nach Prof. *Weber* erst nach Bestandsreinigung gültig ist, so findet man eine gute Uebereinstimmung. Auf Pl. XXII stellen die punktirten Curven

$$\frac{6000}{1{,}0\,p^{\frac{x}{2}}}$$

dar, da in unserem *Sugi*bestand gewöhnlich pro ha 6000 Stämme gepflanzt werden. Es zeigt sich, dass die Stammzahlverminderung für *Sugi* ungefähr der Formel

$$\frac{1}{1{,}0\,p^{\frac{x}{2}}}$$

folgt und zwar liegt der Werth von p

für	die	Bonität	I	zwischen	5,5–6,6
,,	,,	,,	II	,,	ca. 5,0
,,	,,	,,	III	,,	ca. 4,0
,,	,,	,,	IV	,,	3,0–3,6

IV. Grundflächensummen.

Ein Blick auf Pl. XXI lehrt uns, dass die Grundflächensumme in dem ersten Dezennium sehr klein ist, dann aber rasch ansteigt, um zwischen 40–60 Jahren einen Kulminationspunkt

zu erreichen, von dem an eine allmälich immer langsamere Zunahme stattfindet. Je *besser die Bodengüte ist, desto grösser wird die Grundflächensumme, während bei der Stammzahl das Umgekehrte* statt findet.

Die folgende Tabelle dient zum Vergleich.

TAB. XII.

		I Bonität.	II Bonität.	III Bonität.	IV Bonität.	V Bonität.
		Die grösste Grundflächensume im Bestande.				
	Sugi in Japan (beim 100 Jahre)	93,31	85,03	76,76	68,48	—
In Deutschland	Fichte(beim 100–120 Jahre	60–70	56–61	52–53	43–46	36
In Deutschland	Weisstanne (beim 140 Jahre)	67–81	59–67	53–59	48–55	—
In Deutschland	Kiefer (beim 70–140 Jahre)	45–53	41–52	36–41	32–33	25–29

Hieraus ersieht man deutlich, dass die Grundflächensumme der *Sugi* immer grösser ist, als die von deutschen Holzarten. Die *Sugi* besitzen im grossen Durchschnitt 1,5 mal mehr Grundflächensumme als die deutschen Fichten und Weisstannen.

Vergleichen wir unsere Resultate mit den *Weber*'schen Zuwachscurven, deren Gleichung

$$2G = \frac{p^2 x}{1{,}0\, p^x}$$

ist, wo G die Stammgrundflächensumme pro. ha. $1{,}0\, p^x$ den Nenner der Stammzahlformel bedeutet. Da wie wir gefunden haben für *Sugi* immer $1{,}0\, p^{\frac{x}{2}}$ besser passt, als $1{,}0\, p^x$, so benützten wir hier wieder folgende Formel

$$2G = \frac{p^2 x}{1{,}0\, p^{\frac{x}{2}}}$$

Nach dieser Formel construirte ich die Curven auf Pl. XXI, wo ich die direct gefundene Grundflächensumme für *Sugi* zum Vergleich beifügte.

Man sieht auch hier, dass die *Weber*'sche, für *Sugi* durch mich modificirte Formel durch die Beobachtung bestätigt wird; ob aber diese Modification für *Sugi* allein nöthig ist, oder auch

für andere japanische Waldbäume, das ist eine eben so wichtige wie schwierige Frage, die nur dann gelöst werden kann, wenn wir gute Ertragstafeln für andere Waldbäume Japans besitzen werden. Abgesehen von diesen kleinen Abweichungen, die ohne Zweifel durch die klimatischen Verschiedenheit bewirkt worden sind, können wir das Resultat unserer Untersuchung über die *Sugi*bestände in *Kiyosumi* dahin aussprechen, dass sie bestätigt haben, was Prof. *Weber* in seiner "Forsteinrichtung" behauptet hat:

"Je grösser die durch p ausgedrückte Wuchskraft eines Bestandes ist, desto rascher nimmt zwar die Grundfläche des Einzelstammes zu, aber desto schneller sinkt auch die Stammindividuenzahl und zwar erfolgt ersteres nach einer Multiplenreihe der Quadrate von p, letzteres nach dem umgekehrten Werthe einer Exponentialreihe mit der Grundzahl $1.0p$. Stammzahl und Stammgrundfläche stehen demnach in einem durch diese mathematischen Beziehungen ausgedrückten verkehrten Verhältnisse."

V. Durchmesser des Bestandsmittelstammes.

Bei einem Blick auf Pl. XXIII finden wir, dass bei gleichem Alter der Durchmesser mit dem Sinken der Bonität abnimmt; ferner, dass der Zuwachs des mittleren Durchmessers auch mit der *Weber*'schen Formel $D=\sqrt{\frac{4\,p\,x}{u}}$ stimmt wie aus den punktierten Linien ersichtlich wird.

In Folgendem ist ein aus Pl. XXIII entnommenes p mit dem der europaischen Holzarten zusammengestellt.

	I	II	III	IV	V
Der *Sugi* in *Kiyosumi*	1,6	1,2	0,9	0,7	—
Der Weisstanne mittleren Schlussgrades n. *Schuberg*	2	1,6	1,2	0,9	0,6
Der Fichten in Norddeutschland n. *Schwappach*	2	1,4	0,9	0,6	0,4
Der Kiefern in Norddeutschland n. *Schwappach*	1,5–1,7	1,1	0,8	0,6	0,3
Der Kiefern auf Bundsandstein in Hessen n. dems.	1,1	0,9	0,6	0,4	—
Der Kiefern im Gouvernement St. *Petersburg* nach *Wargas de Bedemmar* ..	1,0	0,7	0,5	0,4	0,3

Hieraus ersehen wir, dass die Durchmesserzuwachsenergie des Mittelstammes für unseren *Sugi* geringer ist, als diejenige der europäischen Tanne und Fichte, während die Massenzuwachsenergie der *Sugi* viel grösser ist, als die der letzteren; vielleicht eine Folge des Schlussgrades resp. der Durchforstungsverhältnisse, ein Frage, welche ich später zu erledigen hoffe.

VI. Die Bestandsformzahl.

Ich habe in Pl. XXIV die Bestandsformzahlen nach dem Alter graphisch dargestellt. Hieraus ergibt sich, dass bei gleichem Alter für bessere Bonität die Bestandsformzahl für die Schaft-, so wie auch die für Ast- und Schaftholz immer geringer wird, und dass beide Bestandsformzahlen anfangs sehr gross sind, um dann zunächst rasch bis auf 0,5–0,6 später aber weit langsamer zu sinken. d. h: Die Bestandschaftformzahl ist im 20 jährigen Alter bei I Bonität 0,504

		II	,, 0,573
		III	,, 0,645
		IV	,, 0,671

während im Alter von 30–100 Jahren

bei	I	Bonität	nur von	0,447	bis	0,439
,,	II	,,	,,	,,	0,497	,,	0,467
,,	III	,,	,,	,,	0,552	,,	0,497
,,	IV	,,	,,	,,	0,595	,,	0,526

Aehnlich gestalten sich auch die Bestandsbaumformzahlen. Ast und Schaft), nämlich im

25 jährigen Alter	I	Bonität	0,573
	II	,,	0,651
	III	,,	0,747
	IV	,,	0,845

während im Alter zwischen 35–100 Jahren

bei	I	Bonität	von	0,527	bis	0,464
,,	II	,,	,,	0,583	,,	0,500
,,	III	,,	,,	0,652	,,	0,543
,,	IV	,,	,,	0,716	,,	0,588

Bemerkenswerth ist es hier, dass bei den Bestandsschaftformzahlen besonders für I Bonität im 30 jährigem Alter einmal diese zu einem ersten Minimum sinken, dann wieder bis zum 50 Jahre steigen, um von da ab sehr allmälich wieder zu sinken; jenes Minimum ist aber bei schlechteren Bonitäten nur schwach bemerkbar. Eine diesbezügliche Beobachtung habe ich früher in Deutschland gemacht und hiefür eine mathematische Begründung geliefert. (Siehe: Eine Untersuchungsreihe über den Einfluss der Höhenlage der Gebirge auf die Veränderung des Zuwachses der Waldbäume von S. Honda in der Allgemeinen Forst- und Jagdzeitung 1892).

Der besseren Vergleichbarkeit halber sind nachstehend die Formzahlen der einzelnen Bonitäten nach Altern zusammengestellt.

TAB. XIII.

Die Bestandsschaftformzahl beträgt:

Im Alter.	Bei Bon. I.	Bei Bon. II.	Bei Bon. III.	Bei Bon. IV.
10	0,992	——	——	——
15	0,628	0,714	0,806	0,794
20	0,504	0,573	0,645	0,671
25	0,461	0,517	0,584	0,620
30	0,447	0,497	0,552	0,595
35	0,446	0,492	0,541	0,581
40	0,447	0,488	0,533	0,571
45	0,447	0,488	0,529	0,562
50	0,449	0,485	0,523	0,557
55	0,449	0,484	0,521	0,554
60	0,447	0,481	0,517	0,550
65	0,446	0,479	0,513	0,546
70	0,445	0,477	0,510	0,542
75	0,444	0,475	0,507	0,539
80	0,443	0,473	0,505	0,536
85	0,442	0,471	0.502	0,532
90	0,441	0.470	0,500	0,529
95	0,440	0,468	0,498	0,527
100	0,439	0,467	0,497	0,526

TAB. XIV.

Die Bestandsbaumformzahl beträgt:

Im Alter.	Bei Bon. I.	Bei Bon. II.	Bei Bon. III.	Bei Bon. IV.
10	1,632	——	——	——
15	0,887	1,033	1,219	1,387
20	0,657	0,759	0,884	1,005
25	0,573	0,651	0,747	0,845
30	0,539	0,605	0,684	0,763
35	0,527	0,585	0,652	0,716
40	0,520	0,571	0,630	0,685
45	0,515	0,565	0,616	0,662
50	0,511	0,554	0,603	0,648
55	0,505	0,547	0,594	0,639
60	0,498	0,539	0,585	0,632
65	0,492	0,532	0,577	0,626
70	0,486	0,526	0,571	0,619
75	0,481	0,521	0,565	0,614
80	0,478	0,516	0,560	0,608
85	0,474	0,513	0,555	0,601
90	0,468	0,508	0,549	0,596
95	0,467	0,504	0,546	0,592
100	0,464	0,500	0,543	0,588

Nun betrachten wir die Bestandsschaftformzahlen nach der Scheitelhöhe:

TAB. XV.

Bei einer Seitelhöhe von	I Bonität.	II Bonität.	III Bonität.	IV Bonität.
5–10 m.	628	644	615	599
11–15 m.	483	507	542	561
16–20 m.	447	489	523	541
21–25 m.	448	481	504	527
26–30 m.	446	471	—	—
31–35 m.	441	—	—	—

Die Bestandsschaftformzahlen nehmen also für jede Bonität mit zunehmender Höhe ab und bei gleichen Höhen für schlechtere Bonität zu (mit Ausnahme der Unregelmässigkeit unter 10 m. Höhe).

Die Bestandsbaumformzahlen verhalten sich ebenfalls nach diesem Gesetz, wie aus Tab. 16 ersichtlich:

TAB. XVI.

Bei einer Seitelhöhe von	I Bonität.	II Bonität.	III Bonität.	IV Bonität.
5–10 m.	887	895	816	775
11–15 m.	615	628	655	659
16–20 m.	533	574	600	617
21–25 m.	515	540	558	592
26–30 m.	492	510	—	—
31–35 m.	470	—	—	—

VII. Bestandsrichthöhen.

Der Uebersicht halber folgen nachstehend die Bestandsrichthöhen der einzelnen Bonitäten zuerst nach verschiedenem Alter (Tab. XVII und XVIII). Die Bestandsrichthöhen sowohl an Ast- und Schaftholz als auch an Schaftholz, beginnen wie man daraus ersehen wird, niedrig und steigen mit zunehmendem Alter allmälich an.

TAB. XVII.

Die Bestandsrichthöhe für Schaftholz beträgt:

Im Alter.	Bei Bon. I.	Bei Bon. II.	Bei Bon. III.	Bei Bon. IV.
15	4,9	4,4	3,8	2,5
20	5,7	5,2	4,5	3,2
25	6,6	6,1	5,3	4,0
30	7,6	6,9	6,1	4,8
35	8,5	7,8	6,9	5,6
40	9,3	8,6	7,6	6,3
45	10,1	9,3	8,3	7,0
50	10,8	10,0	8,9	7,6
55	11,4	10,5	9,5	8,1
60	11,8	11,0	10,0	8,7
65	12,3	11,5	10,4	9,1
70	12,7	11,9	10,8	9,5
75	13,0	12,2	11,2	9,9
80	13,3	12,5	11,5	10,2
85	13,6	12,7	11,7	10,4
90	13,8	13,0	11,9	10,7
95	14,0	13,1	12,1	10,9
100	14,2	13,3	12,3	11,0

TAB. XVIII.

Die Bestandsrichthöhe für Schaft und Astholz beträgt:

Im Alter.	Bei Bon. I.	Bei Bon. II.	Bei Bon. III.	Bei Bon. IV.
15	6,9	6,4	5,7	4,3
20	7,5	6,9	6,1	4,7
25	8,3	7,7	6,8	5,4
30	9,1	8,4	7,5	6,2
35	10,0	9,3	8,3	6,9
40	10,8	10,1	9,0	7,6
45	11,6	10,8	9,7	8,2
50	12,2	11,4	10,3	8,8
55	12,8	11,9	10,8	9,4
60	13,2	12,3	11,3	10,0
65	13,6	12,7	11,7	10,5
70	13,8	13,1	12,1	10,9
75	14,1	13,4	12,4	11,3
80	14,4	13,6	12,7	11,6
85	14,6	13,9	12,9	11,8
90	14,7	14,0	13,1	12,0
95	14,9	14,2	13,3	12,2
100	15,0	14,3	13,5	12,4

VIII. Das Zuwachsprocent.

Der Verminderungsgang des Zuwachsprocentes ist in Pl. XXVII und XXVIII graphisch dargestellt; man sieht, dass das Zuwachs procent des Bestandes sehr gross anfängt, dann sehr rasch und später langsamer sinkt.

IX. Der Normalvorrath.

In Pl. XXIX haben wir den Zuwachsgang des Normalvorrathes mit starkgezogenen Linien gezeichnet und daneben mit punktirten Linien Zinseszinsreihen ($1{,}0p^u - 1$) zum Vergleich.

Es ergiebt sich hieraus, dass die einer jeden Standortklasse entsprechenden Normalvorräthe mit der Länge der Umtriebszeit 50–70 Jahre lang nahezu wie Potenzreihen zunehmen, und dass mit geringerer Bonität p abnimmt.

Dieses p für Ast- und Schaftholz ist zum Vergleich mit dem p von deutschen Wäldern in folgender Tabelle zusammengestellt:

TAB. XIX.

Auf Grund der Ertragstafeln für:	I Bon.	II Bon.	III Bon.	IV Bon.	V Bon.
	Procent p für die Reihen $1{,}0p^u - 1$.				
Buchen nach *F. v. Baur* ..	4–3,5	3,7–3,3	3,3–3	2,9–2,7	2,4
Fichten nach demselben ..	5–4,5	4,5–4,0	4,9–3,5	3,3–3	—
Fichten nach *Kunze*	5,5–5	5–4,5	4,5–4	3,7–3	—
Kiefern nach *Schwappach* .	4,5–4	4–3,5	3,5–3	3,3–2,9	2,5
Sugi in Japan	6,8–6,0	6,0	5,5–5,0	4,6	—

Die Zuwachsenergie der Normalvorräthe für *Sugi* ist also etwas grösser, als die für deutsche Holzarten.

X. Das Nutzungsprocent.

Die Grössen der Nutzungsprocente sind in Pl. XXVII und XXVIII graphisch dargestellt, woraus hervorgeht, dass die Nutzungsprocente mit schlechterer Bonität grösser werden und dass sie mit steigendem Alter allmählig abnehmen.

Um die absolute Grösse der Nutzungsprocente an der ganzen Holzmasse mit derjenigen deutscher Holzarten zu vergleichen, habe ich in Tab. XX die betreffenden Daten zusammengestellt, woraus man erkennt, dass das Zuwachsprocent für unseren *Sugi* kleiner als für deutsche Fichten und Weisstannen, aber etwas grösser als für deutsche Kiefer ist.

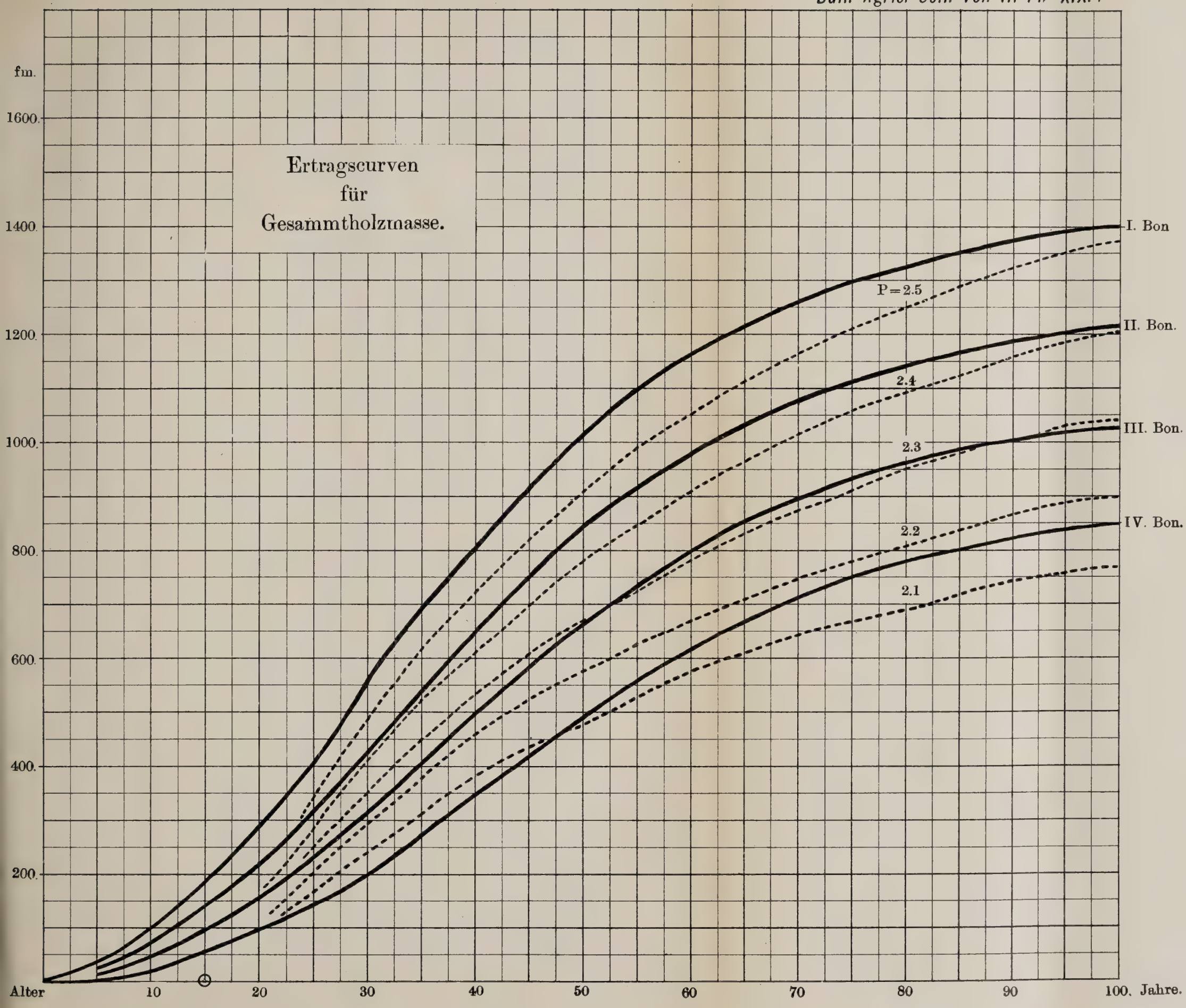
Ertragscurven für Schaftholzmasse.

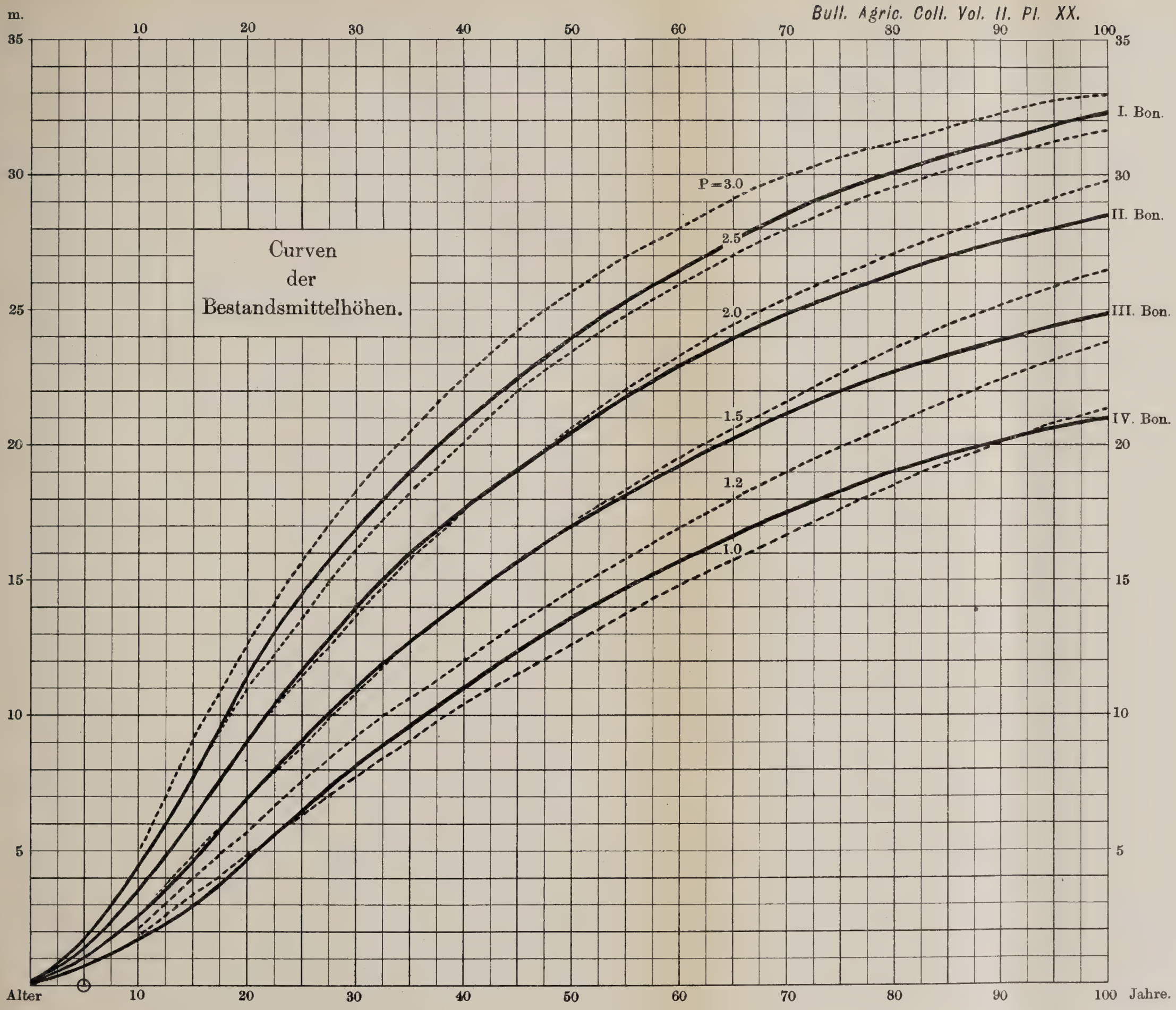
fm.

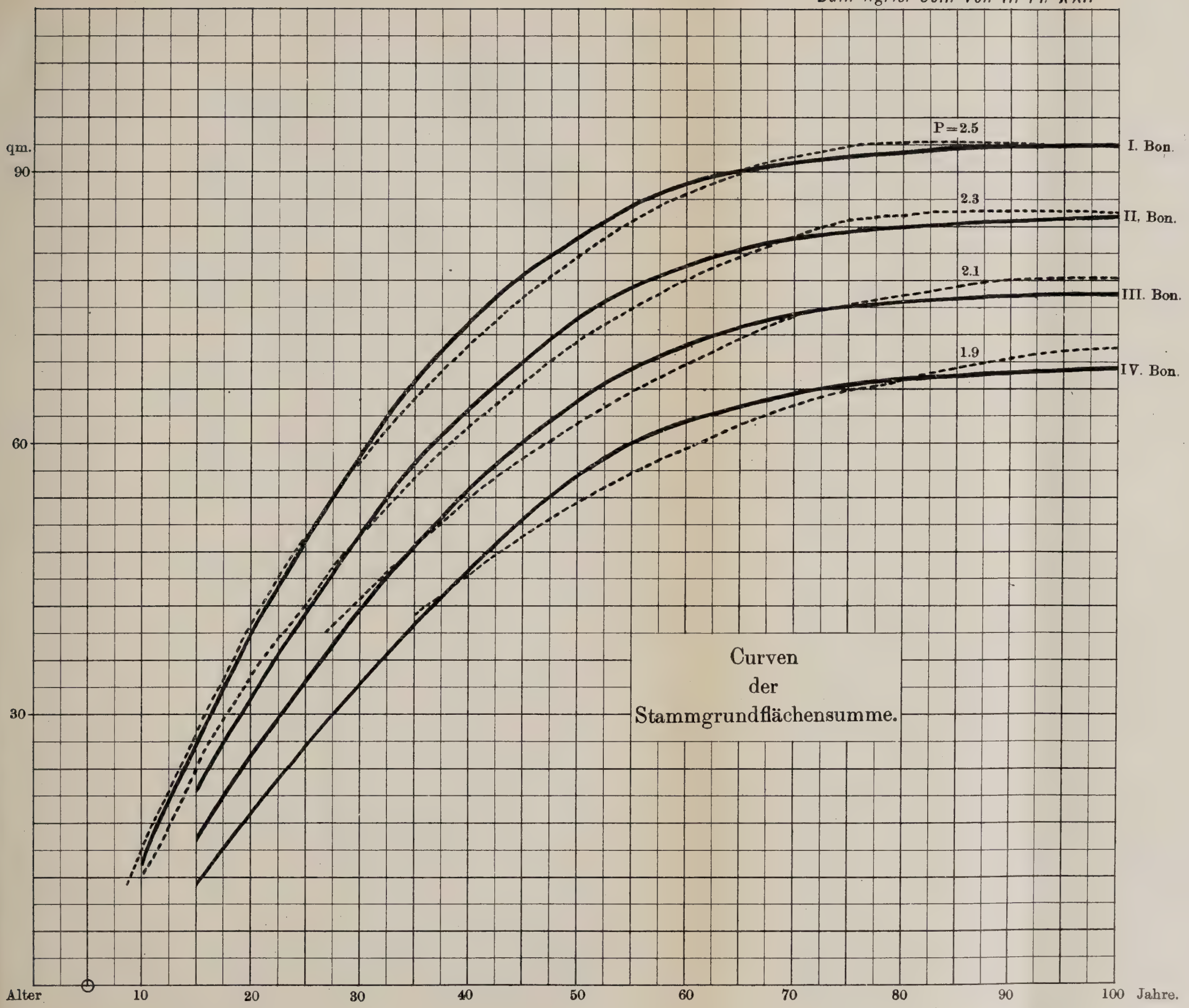
1400
1200
1000
800
600
400
200

P=2.5
I. Bon.
2.4
II. Bon.
2.3
III. Bon.
2.2
2.1
IV. Bon.

Alter 10 20 30 40 50 60 70 80 90 100 Jahre.


Ertragscurven
für
Gesammtholzmasse.
fm.
1600.
1400.
1200.
1000.
800.
600.
400.
200.
Alter
10
20
30
40
50
60
70
80
90
100. Jahre.
I. Bon
II. Bon.
III. Bon.
IV. Bon.
P=2.5
2.4
2.3
2.2
2.1


m.
10
20
30
40
50
60
70
80
90
100
35
30
25
20
15
10
5
Curven
der
Bestandsmittelhöhen.
P=3.0
2.5
2.0
1.5
1.2
1.0
I. Bon.
II. Bon.
III. Bon.
IV. Bon.
Alter
Jahre.


qm.
90
60
30
P=2.5
I. Bon.
2.3
II. Bon.
2.1
III. Bon.
1.9
IV. Bon.
Curven
der
Stammgrundflächensumme.
Alter
10
20
30
40
50
60
70
80
90
100
Jahre.

Stamm.
Zahlen.

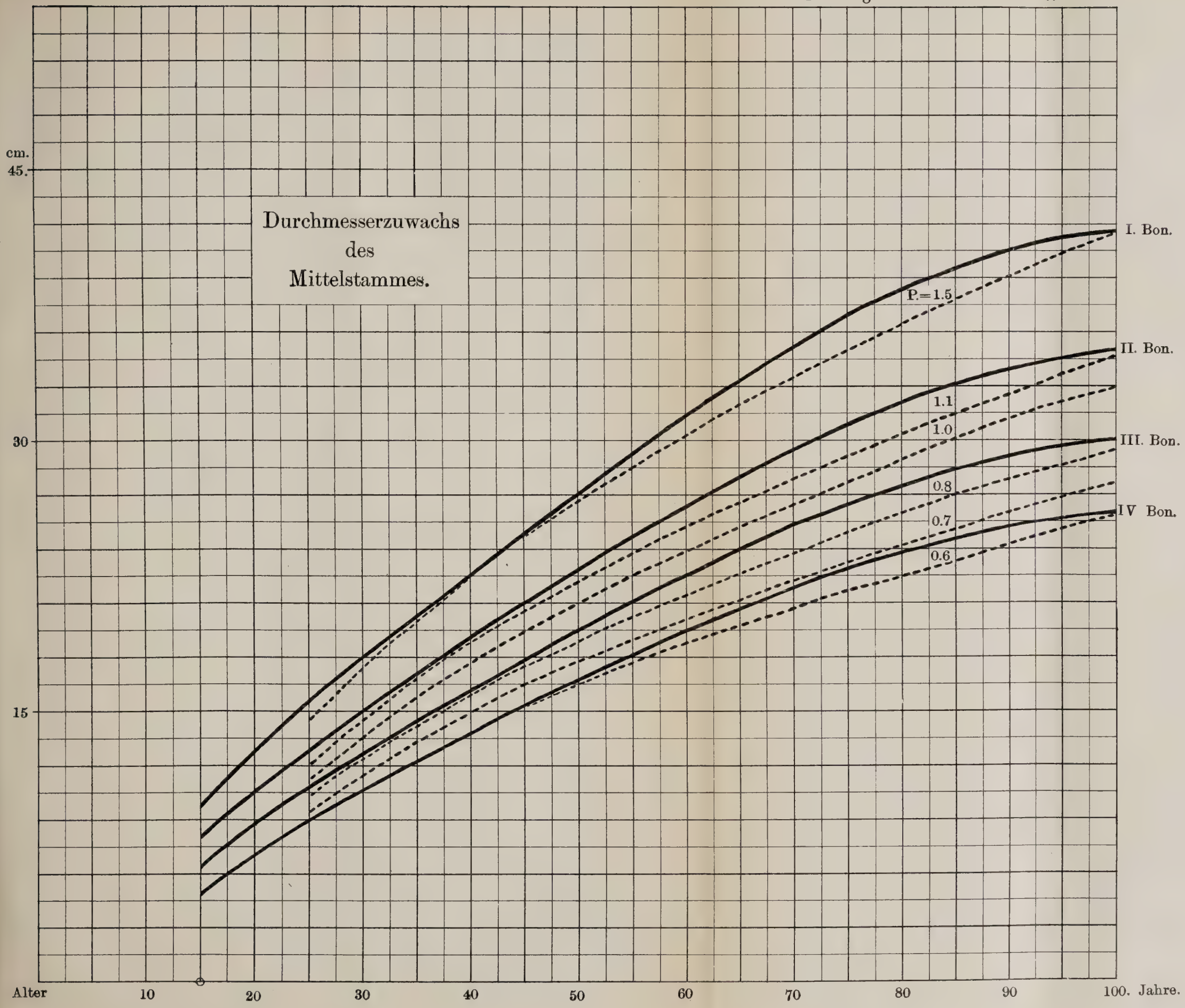
5400.
5100.
4800.
4500.
4200.
3900.
3600.
3300.
3000.
2700.
2400.
2100.
1800.
1500.
1200.
900.
600.
300.
0

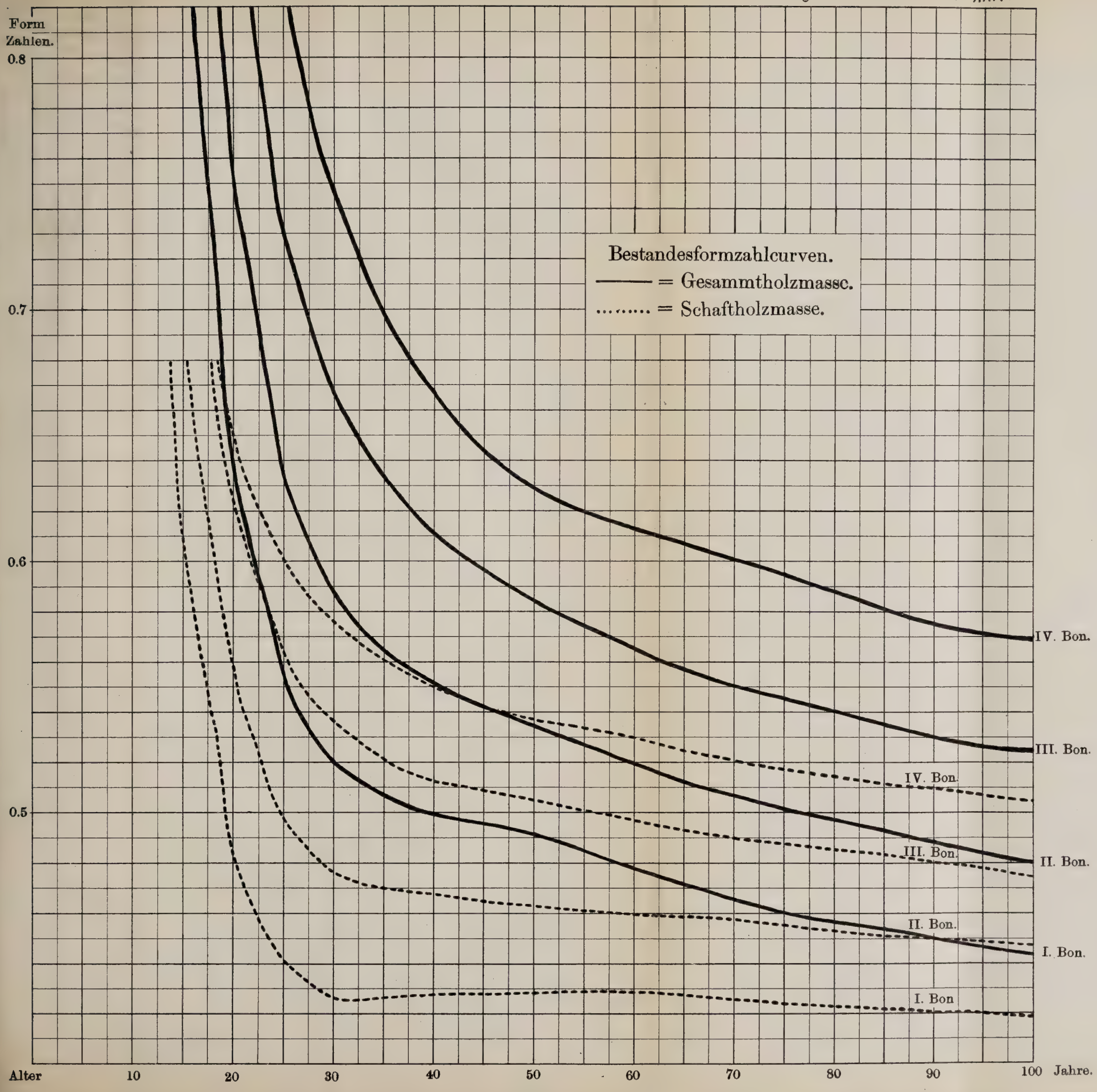
IV. Bonität
III. Bonität
II. Bonität
I. Bonität

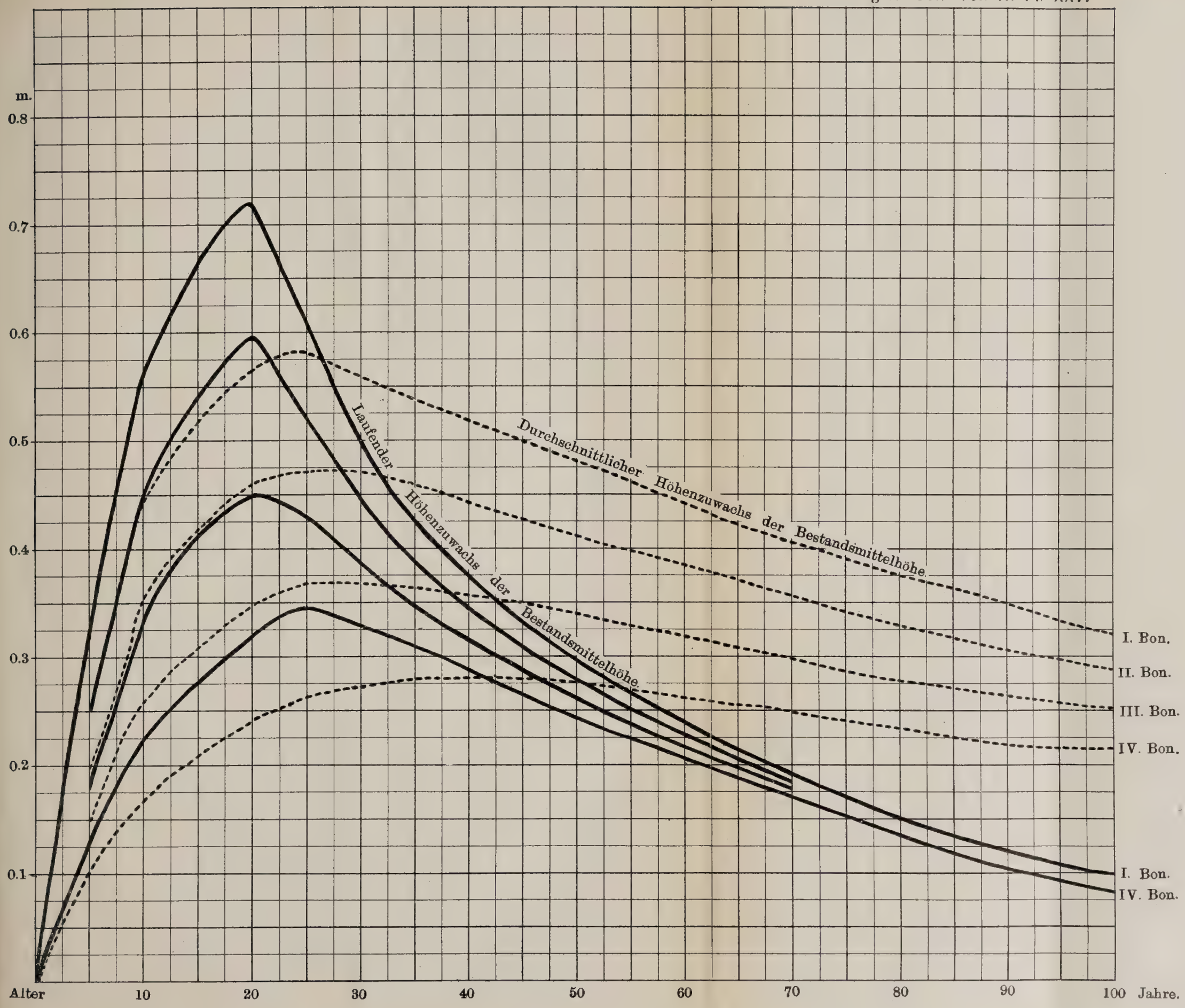
6,5%
6,0%
5,0%
4,0%
3,5%

Curven
der
Stammzahlverminderungen.

Alter. 10. 20. 30. 40. 50. 60. 70. 80. 90. 100. Jahre.


cm.
45.
30
15
Durchmesserzuwachs
des
Mittelstammes.
I. Bon.
II. Bon.
III. Bon.
IV Bon.
P.=1.5
1.1
1.0
0.8
0.7
0.6
Alter
10
20
30
40
50
60
70
80
90
100. Jahre.


Form Zahlen.
0.8
0.7
0.6
0.5
Bestandesformzahlcurven.
——— = Gesammtholzmasse.
..... = Schaftholzmasse.
IV. Bon.
III. Bon.
IV. Bon.
II. Bon.
III. Bon.
II. Bon.
I. Bon.
I. Bon
Alter
10
20
30
40
50
60
70
80
90
100 Jahre.


m.
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
Laufender Höhenzuwachs der Bestandsmittelhöhe
Durchschnittlicher Höhenzuwachs der Bestandsmittelhöhe
I. Bon.
II. Bon.
III. Bon.
IV. Bon.
I. Bon.
IV. Bon.
Alter
10
20
30
40
50
60
70
80
90
100 Jahre.

für
Schaftholzmasse.

fm.
26
24
22
20
18
16
14
12
10
8
6
4
2

Laufender jährlicher Massenzuwachs.

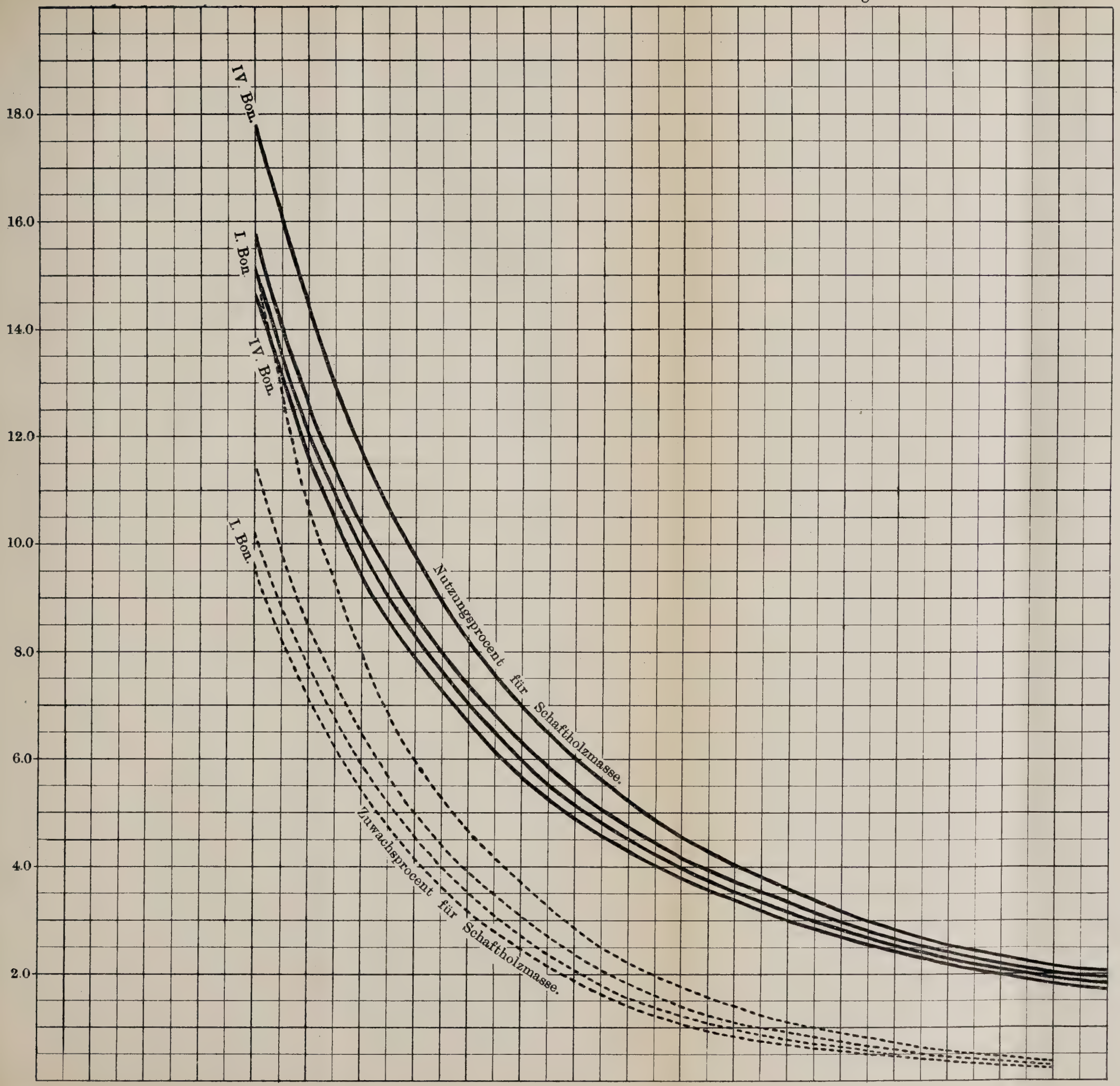
Durchschnitts- Zuwachs.

P = 2.5
2.4
2.3
2.2
2.1

I. Bon.
II. Bon.
III. Bon.
IV. Bon.

I. Bon.
II.
III.
IV.

Alter 10 20 30 40 50 60 70 80 90 100 Jahre.


IV. Bon.
I. Bon.
IV. Bon.
I. Bon.
Nutzungsprocent für Schaftholzmasse.
Zuwachsprocent für Schaftholzmasse.
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
Alter
10
20
30
40
50
60
70
80
90
100
Jahre.

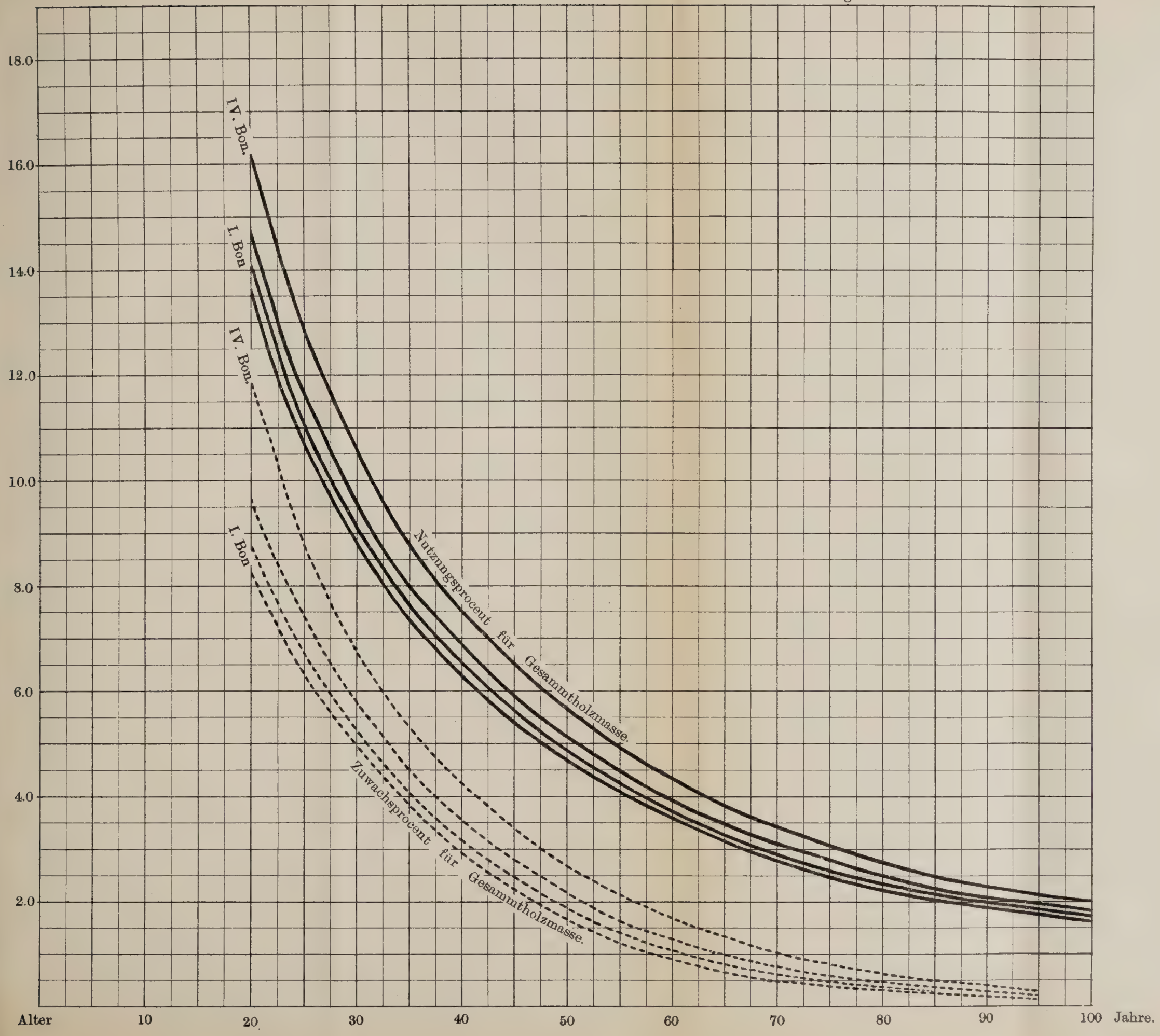

18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
IV. Bon.
I. Bon.
IV. Bon.
I. Bon.
Nutzungsprocent für Gesammtholzmasse.
Zuwachsprocent für Gesammtholzmasse.
Alter
10
20
30
40
50
60
70
80
90
100 Jahre.

Fig. 1.
Normalvorrath
für
Gesammt Holzmasse.

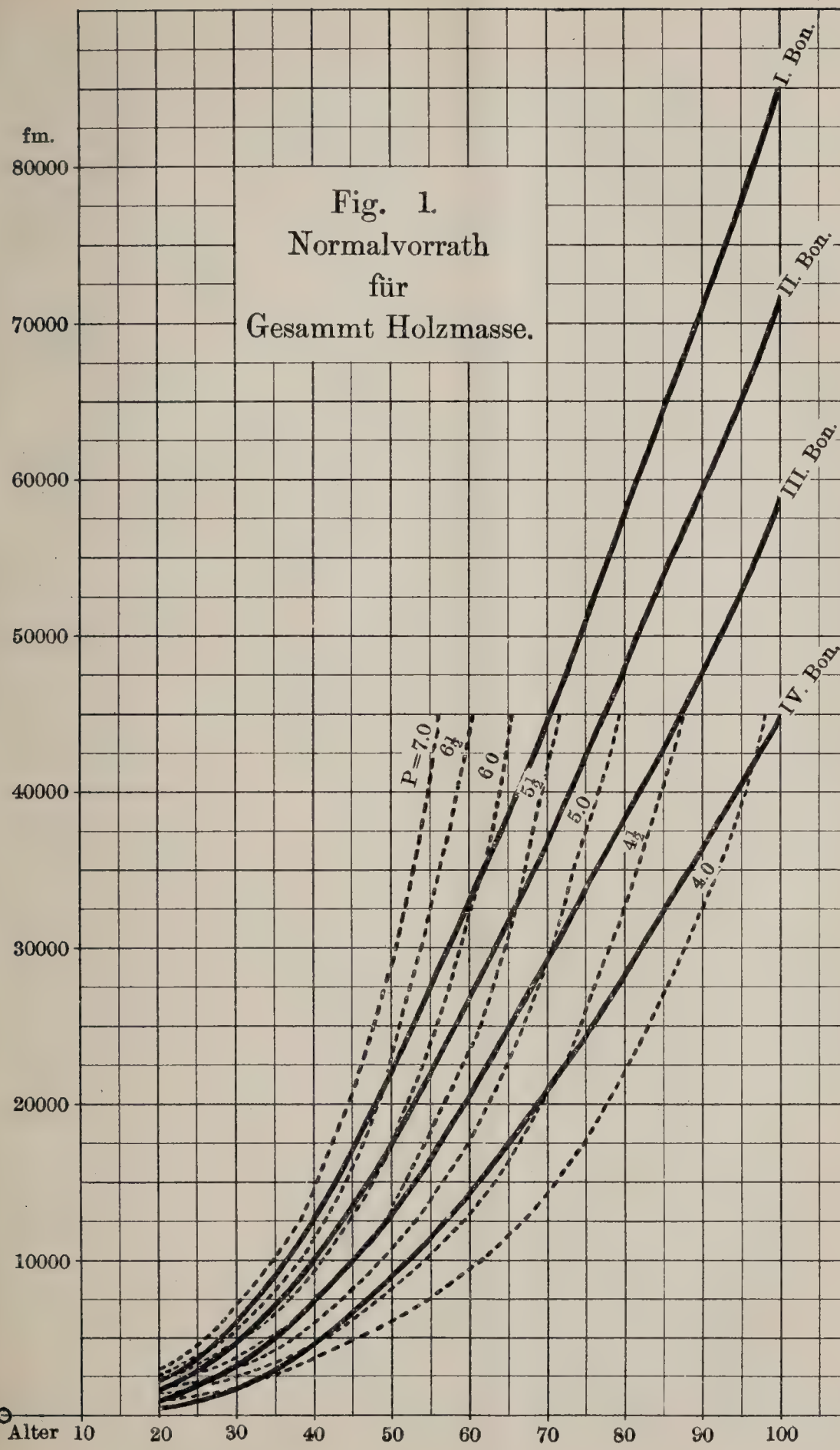
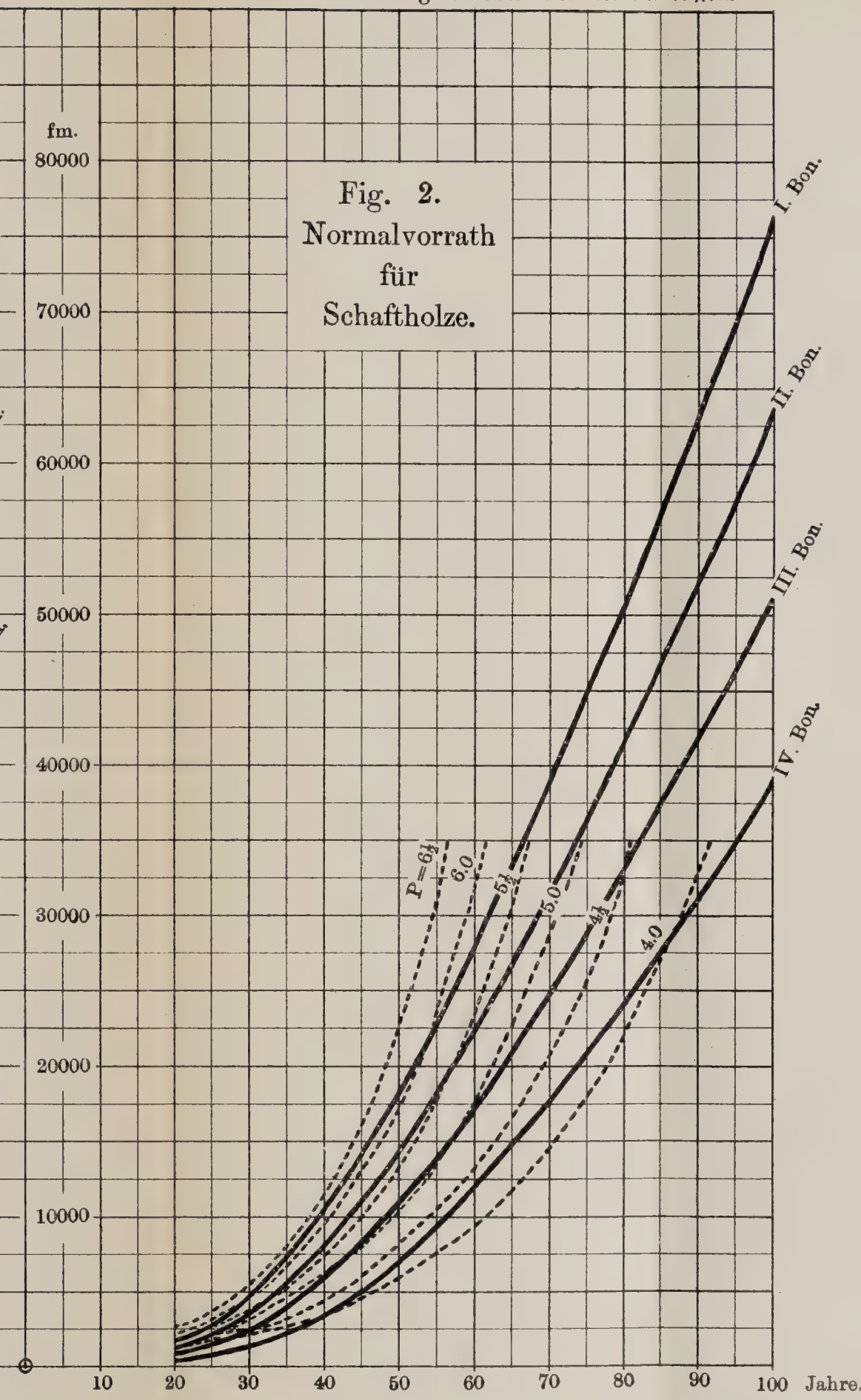


Fig. 2.
Normalvorrath
für
Schaftholze.



TAB. XX.

Umtriebsjahre.	20	30	40	50	60	70	80	80	100
	Nutzungsprocent für die Gesammte Holzmasse.								
	I Bonität.								
Fichten nach R. *Hartig* ..	21,3	14,2	11,3	7,98	5,97	4,81	4,07	3,48	3,03
Weisstannen n. *Schuberg* ..	14,3	12,1	8,29	5,52	4,10	3,24	2,68	2,30	1,96
Kiefern nach *Schwappach* ..	10,5	6,98	5,11	3,96	3,20	2,65	2,26	1,95	1,70
Sugi in Japan	13,6	8,8	6,3	4,7	3,6	2,84	2,3	1,9	1,7
	II Bonität.								
Fichten nach *R. Hartig* ..	16,7	19,1	12,6	7,96	6,02	4,72	3,97	3,44	3,04
Weisstannen n. *Schuberg* ..	14,1	11,5	8,52	5,91	4,39	3,41	2,84	2,39	2,06
Kiefern nach *Schwappach* ..	10,8	7,10	5,41	4,06	3,30	2,74	2,32	1,98	1,74
Sugi in Japan	14,0	9,0	6,5	4,9	3,7	2,9	2,4	2,0	1,7
	III Bonität.								
Weisstannen n. *Schuberg* ..	14,4	11,1	8,65	6,27	4,70	3,70	3,03	2,54	2,18
Kiefern nach *Schwappach* ..	10,9	7,52	5,32	4,06	3,24	2,69	2,29	1,98	1,74
Sugi in Japan	14,5	9,5	6,8	5,1	3,9	3,1	2,5	2,1	1,8
	IV Bonität.								
Weisstannen n. *Schuberg* ..	14,1	10,8	8,6	6,75	5,05	4,00	3,28	2,74	2,34
Kiefern nach *Schwappach* ..	11,1	7,57	5,66	4,39	3,51	2,85	2,39	2,04	1,76
Sugi in Japan	16,1	10,5	7,5	5,6	4,3	3,4	2,7	2,3	1,9

Ueber den Einfluss wechselnder Mengen von Kalk und Magnesia auf die Entwicklung der Nadelbäume.

VON

Oscar Loew und **Seiroku Honda.**

Es ist seit lange anerkannt, dass Kalkboden für die Landwirthschaft einen vorzüglichen Boden abgibt, und auch im Forstbetrieb weiss man ihn zu schätzen. Kiefern gedeihen besonders gut auf demselben. Der Kalk ist stets von mehr oder weniger Magnesia begleitet, ein weiterer wichtiger Nährstoff für die Pflanzen, welcher aber unter gewissen Bedingungen auch schädlich wirken kann, nämlich wenn seine Menge die des Kalks bedeutend überwiegt. Bei Experimenten mit Nährlösungen lässt sich das leicht beobachten,[1] besonders wenn der Kalk ganz eliminirt wird. Aber dieser schädliche Einfluss wird weit langsamer sich bemerklich machen, wenn wie im Boden die Magnesia als schwerlösliches Carbonat vorhanden ist. Nichts destoweniger ist auch hier ein Unfruchtbarwerden durch zu hohen Magnesiagehalt beobachtet worden.[2] So lange die Menge der Magnesia geringer ist als die des Kalks ist diese Gefahr wohl ausgeschlossen wie z. B. beim Dolomitboden, wie *Kellner* mittheilt[3] und *Voelker* in England[4] sowie *Muntz* und *Girard* in Frankreich[5] berichten.

Da uns die Frage interessirte, bis zu welchem Grade die Entwicklung der Nadelbäume eine Störung durch steigende Mengen von Magnesia im Boden erfahren können, stellten wir einen Versuch mit jungen Pflanzen von *Cryptomeria japonica*, *Thuja obtusa* und *Pinus densiflora*, den drei wichtigsten Wald-

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(1) *Wolff*, Landw. Versuchs-Stationen 6,218; *Raumer* und *Kellermann*, Ibid. 25,31; *O. Loew*, Ibid. 41,469.

(2) *Adolf Mayer's* Vorlesungen über Agriculturchemie II, S. 111 (3. Aufl.)

(3) Sächsische Landw. Zeitschrift 1895, Nr. 24.

(4) Griffiths, Treatise on Manures 1889, S. 235.

(5) Les Engrais III, S. 333.

bäumen Japans, an. Die Pflanzen wurden am 4. Mai 1894 in 5 Töpfe verpflanzt (je zwei Stück). Jeder Topf enthielt 5 Kilo Quarzsand, welcher vorher, um alle leicht löslichen Mineralsalze zu entfernen, mit concentrirter Salzsäure zwei Tage lang unter öfterem Umrühren stehen blieb, was nochmals mit frischer Salzsäure wiederholt wurde. Dann wusch man mit destillirtem Wasser, bis sich keine saure Reaction auf Lakmus mehr zeigte.

Die jungen Pflanzen wurden sämmtlich von Zeit zu Zeit mit derselben Hauptloesung begossen, welche pro 100 cc. enthielt:

Dikaliumphosphat	1 g
Chlorkalium	1 g
Ammoniumsulfat	2 g
Eisenvitriol	0,1 g.

Jeder Topf erhielt von Zeit zu Zeit 50 cc. dieser Loesung,[1] was vom 5. Mai bis 23. December 1894 34 mal und von 2. Februar bis 28 September 1895 35 mal stattfand. Ausser dieser Hauptloesung wurden noch zwei specielle Loesungen hergestellt, deren eine 1 procent Calciumnitrat und die andere 1 procent krystallisirtes Magnesiumsulfat enthielt. Von diesen Loesungen erhielten nach jedesmaligem Begiessen mit jener Hauptloesung:

Topf Nr.	I	II	III	IV	V.	
Calciumnitrat-Loesung[2]	50	45	25	10	—	cc.
Magnesiumulfat-Loesung	—	5	25	40	50	cc.

Nach einem Jahre war ein ganz erheblicher Unterschied bei den Pflanzen wahrzunehmen, der gegen den Herbst des

---

(1) Diese Salzmenge mag auf den ersten Anblick hoch bemessen sein, indessen wenn man bedenkt, dass der grobe Sand keine Absorptionskraft besitzt, dass die Pflanzen in der Zwischenzeit oft mit destillirtem Wasser—besonsers reichlich während der heissen Monate—begossen werden mussten und also die Salze hald in die Tiefe des Topfes geführt wurden, wird man unser Verfahren gerechtfertigt finden.

(2) Bei dem Ueberschuss an Stickstoff und Schwefel, der in Form von Ammoniumsulfat in der Hauptloesung gegeben wurde, konnte sicherlich der Umstand wenig mehr ins Gewicht fallen, dass das Calcium als Nitrat, des Magnesium aber als Sulfat gegeben wurde. Beide wurden überdiess durch die vorher applicirte Hauptloesung zum grössten Theil in Phosphate verwandelt.—

zweiten Jahres noch bedeutend zunahm. Am 5. October 1895 nahmen wir eine nähere Vergleichung der Unterschiede vor und liessen eine photographische Aufnahme (Pl. XXX) herstellen. Die Resultate sind in folgenden Tabellen angegeben.

TAB. I.—CRYPTOMERIA JAPONICA (*SUGI*).

No. des Topfes.	I		II		III		IV		V	
Versuchspflanzen.	a	b	a	b	a	b	a	b	a	b
Länge der Keimpflanze..	9,8	9,0	7,1	6,0	7,7	7,5	7,0	7,5	5,5	8,5
Höhe im I Jahre	11,8	12,5	9,7	9,0	12,5	11,0	10,0	11,5	8,7	11,2
„ „ II „	19,0	20,8	20,7	17,8	27,5	17,5	22,0	18,0	16,8	17,3
Längster Zweig im I Jahre	18,0	12,0	14,5	10,3	11,5	7,6	11,0	10,7	10,6	8,3
Längster Zweig im II Jahre	18,0	13,0	18,4	15,0	18,0	9,7	15,2	13,8	13,8	12,7
Zahl der Zweige im I Jahre	3	5	3	4	4	4	4	4	3	3
Zahl der Zweige im II Jahre	5	5	7	7	9	9	4	5	8	6
Gesammt Gewicht beider Pflanzen in gr. im frischen Zustande ..	28,2		44,0		40,1		26,5		22,7	

Die Exemplare von Topf II und III waren am kräftigsten entwickelt, die Zweige standen mässig nach aufwärts gerichtet, und die Nadeln waren von frischem Grün; während in Topf I (ohne Magnesia) und in Topf V (ohne Kalk) die jungen Triebe schlecht entwickelt waren, die schwachen Zweige nach abwärts hingen und die dünnen Nadeln eine gelbliche Färbung hatten.[1]

Ganz ähnliche Unterschiede ergaben sich bei *Thuja obtusa*:

(1) *Ebermayer* hat nachgewiesen ("Lehre von der Waldstreu"), dass zur Aus bildung der *Blätter* in einem Buchen-oder Fichtenhochwalde 5–6 mal mehr Mineralstoffe verwendet werden, als zur jährlichen *Holz*production.

TAB. II.—THUJA OBTUSA.

No. des Topfes.	I		II		III		IV		V	
Versuchspflanzen.	a	b	a	b	a	b	a	b	a	b
Länge der Keimpflanze..	5,0	4,0	5,5	4,7	5,0	3,5	5,0	4,5	6,5	4,5
Höhe im II Jahre cm. ..	15,9	11,5	17,8	16,4	16,4	11,5	16,7	12,7	19,6	13,9
Längster Zweig im I Jahre cm.	10,0	2,0	12,0	6,0	10,6	2,5	10,4	6,8	10,5	10,0
Längster Zweig im II Jahre cm.	9,6	7,3	7,6	8,0	14,0	7,0	8,5	7,3	10,4	8,9
Zahl der Zweige im I Jahre	8	7	10	9	10	7	7	9	8	8
Zahl der Zweige im II Jahre	3	7	8	6	6	7	10	6	5	5
Gesammt-Gewicht beider Pflanzen in gr. im frischen Zustande ..	15,6		20,8		19,7		16,4		15,8	

TAB. III.—PINUS DENSIFLORA (*MATSU*).

No. des Topfes.	I		II		III		IV		V	
Versuchspflanzen.	a	b	a	b	a	b	a	b	a	b
Länge der Keimpflanze..	13,8	8,9	15,0	12,0	—	—	14,5	7,4	—	8,5
Höhe im I Jahre	15,1	9,5	16,2	(13,0)	—	—	16,3	8,6	—	9,5
„ „ II „	24,8	13,6	29,9	(15,2)	—	—	25,5	12,5	—	18,0
Grösste Nadellänge im I Jahre	10,8	10,6	10,3	8,3	—	—	10,9	6,9	—	8,4
Grösste Nadellänge im II Jahre..	11,5	12,0	14,0	10,5	—	—	10,0	7,3	—	3,7
Gewicht im frischen Zustande	11,5	3,0	15,6	(2,7)	—	—	10,6	2,3	—	1,6

In Topf Nr. III wurden hier leider durch Insektenfrass beide Pflanzen und in Nr. V die grössere der beiden Pflanzen beschädigt und daher nicht weiter berücksichtigt, Eine geringe Beschädigung hierdurch erfuhr auch die kleinere Kiefer in Topf

II, und die betreffenden Zahlen sind daher in den Tabellen eingeklammert.

Gelbliche Färbung der Nadeln, war nur in Topf I und V zu beobachten; auch waren in beiden diesen Fällen die Nadeln am dünnsten, bei I zwar noch von beträchlicher Länge, bei V jedoch auffallend klein, so dass der Kalkmangel hier in auffälligster Weise im zweiten Jahre sich bemerkbar machte.

In folgenden Tabellen ist das Höhenzuwachsprocent, sowie die Zahl der Zweige und die Differenzen der grössten Nadellängen bei der Kiefer im ersten und zweiten Jahre angegeben:

TAB. IV.—CRYPTOMERIA JAPONICA.

Nummer des Topfes.	Versuchspflanzen.	Höhenzuwachsprocent im		Zweigzahl im I und II Jahre.
		I Jahre.	II Jahre.	
I	a	20,41	61,02	8
	b	38,89	66,40	10
	Durchschnitt	29,65	63,71	9
II	a	36,62	113,40	10
	b	50,00	120,00	11
	Durchschnitt	43,31	116,70	10,5
III	a	62,34	120,00	13
	b	46,67	77,27	13
	Durchschnitt	54,51	98,64	13
IV	a	42,86	120,00	8
	b	53,33	56,52	9
	Durchschnitt	48,10	88,26	8,5
V	a	58,18	93,10	11
	b	31,76	54,46	9
	Durchschnitt	44,97	73,76	10,5

Hieraus ergiebt sich, dass im zweiten Versuchsjahre die Abwesenheit des Kalks sowohl als der Magnesia das Höhenzuwachsprocent sehr bedeutend herabsetzte. Die Zweigzahl war bei Nr. III am grössten, während bei V (ohne Kalk) zwar

soviel *Z*weige wie bei II gebildet, aber doch nur äusserst kurz waren, wie aus der Photographie ersichtlich ist. Siehe Pl. XXX.

TAB. V.—THUJA OBTUSA.

Nummer des Topfes.	Höhenzuwachsprocent der Keimpflanze bis zum II Jahre.			Zweigzahl im I und II Jahre.		
	a	b	Durchschnitt	a	b	Durchschnitt
I	218,09	187,50	202,75	11	14	12,5
II	223,63	248,93	236,28	18	15	16,5
III	228,00	228,57	228,29	16	14	15,0
IV	234,00	180,22	207,11	17	15	16,0
V	201,54	208,89	205,22	13	13	13,0

Auch aus diesen Daten folgt eine schlechte Entwickelung bei I und V. Die *Z*weigzahl ist am grössten bei II, III und IV, also bei gleichzeitigem Vorhandensein von Kalk und Magnesia.

TAB. VI.—PINUS DENSIFLORA.

Nummer des Topfes.	Versuchspflanzen.	Höhenzuwachsprocent im		Die grössten Nadeln im II Jahre sind länger als die im I Jahre.
		I Jahre.	II Jahre.	
I	grössere	9,42	64,24	0,70 cm.
	kleinere	6,74	43,16	1,40
	Durchschnitt	8,08	53,70	1,05
II	grössere	8,00	84,57	3,70
	kleinere	8,33	(16,92)	2,20
	Durchschnitt	8,18	(50,75)	2,95
IV	grössere	12,41	56,44	0,90
	kleinere	16,22	45,34	0,40
	Durchschnitt	14,32	50,89	0,65
V	grössere	—	—	—
	kleinere	11,76	36,84	—4,70 cm.
	Durchschnitt	—	—	—

Das Höhenzuwachsprocent blieb somit hier im zweiten Versuchsjahre bei Kalkmangel (V) bedeutend hinter den andern Fällen zurück. Interessant ist die bedeutende Längenzunahme der Nadeln in Topf II, sowie die beträchtliche Längenabahme in Topf V im zweiten Jahre. Man wird auch an der Photographie (Pl. XXX Reihe A) die *Abhängigkeit der Nadellänge von der Kalkzufuhr* leicht erkennen können.

TAB. VII.—GEWICHT IN GR. IM FRISCHEN ZUSTANDE.

Nummer des Topfes.	I	II	III	IV	V
Cryptomeria japonica.. ..	28,2	44,0	40,1	26,5	22,7
Thuja obtusa	15,6	20,8	19,7	16,4	15,8
Pinus densiflora grössere ..	11,5	15,6	—	10,6	—
,, ,, kleinere ..	3,0	(2,7)	—	2,3	1,6

Die Gewichte im frischen Zustande wurden bestimmt, nachdem man die Pflanzen aus dem gelockerten Kies vorsichtig auszog, den Sand abwusch, und die Wurzeln anhaltend zwischen Fliesspapier abtrocknete.

Bei *Pinus* war die Reihe wie schon oben erwähnt nicht vollständig; doch bei *Cryptomeria* und *Thuja*, ergiebt sich, dass die Pflanzen der Töpfe Nr. II und III am meisten zugenommen hatten, also da, wo die Menge Magnesia die des Kalks noch nicht überschritt, und dieser Umstand mag wohl bei Bestimmung der Bonitätsklassen der Bodenarten in Berücksichtigung zu ziehen sein.

Die Unterschiede bei *Cryptomeria* sind bedeutender wie die bei *Thuja*, was wohl dadurch erklärt werden kann, dass jene weit mehr Ansprüche an den Boden stellt als letztere, wesshalb sie auch nur auf guten Boden überhaupt gezogen wird.

Noch möchte die Frage gestellt werden, warum in den Töpfen I und V, also bei Abwesenheit von Magnesia resp. Abwesenheit von Kalk, im zweiten Jahre überhaupt noch eine Entwickelung stattfinden konnte. Darauf mag geantwortet werden, dass die Versuchspflänzchen aus einem guten Boden

		—		
		—		

Reihe A.

Reihe B.

stammten und daher wohl von beiden Stoffen etwas aufgespeichert enthielten.[1]

Berechnen wir aus den Mengen der angewandten Magnesia- und Kalksalze die Mengen der freien Basen Magnesia und Kalk, so ergiebt sich als Verhältniss nahezu:

			MgO	:	CaO
für	Topf	II	1	:	20
„	„	III	1	:	2
„	„	IV	1	:	0,5

Wir sehen somit aus den Ergebnissen des Topfes IV, dass ein nachteiliger Effect producirt wird, wenn die Menge des Kalks unter die der Magnesia sinkt,[2] während anderseits ein bedeutender Ueberschuss an Kalk wie bei Topf II nur günstig wirkte. Offenbar wird die für die Ernährung notwendige Magnesia auch dann noch mit Leichtigkeit von der Pflanze aufgenommen, wenn sie in sehr geringer Menge vorhanden ist, wie in Topf II.

Noch seien einige Bemerkungen betreffs der Reihe B der beigefügten photographischen Abbildung gemacht. In diesem Falle waren sämmtliche Salze dem Sande direkt einverleibt worden, und fand die Begiessung nur mit distillirtem Wasser statt, und nicht mit Salzlösungen. Hier konnten daher bei dem mangelnden Absorptionsvermögen des Sandes die Bestandtheile rasch in den Untergrund geführt werden und daher eine Aenderung der relativen Verhältnisse in den oberen Schichten, aus denen die Wurzeln vorzugsweise ihre mineralischen Baustoffe entnahmen, stattfinden. Man erkennt zwar auch hier auf den ersten Blick das Zurückbleiben der Entwicklung bei Mangel an Magnesia oder Kalk (siehe I und V); dass aber bei No. IV der Unterschied von II und III weniger markant ist als in Reihe A mag auf dem erwähnten Umstande beruhen.

Die wesentlichen Schlüsse welche wir aus unseren Beobachtungen ziehen können, scheinen uns folgende zu sein:

---

(1) Ueberdies ist die Entwickelung der Koniferen in den ersten Jahren ja weit langsamer, als die der Laubhölzer und vieler anderer Gewächse.

(2) Nach *Rudolf Weber's* umfangreichen Untersuchungen enthält sowohl Kernholz als Splintholz 2–4 mal so-viel Kalk als Magnesia, und wird bei der Samenbildung die Magnesia aus dem Holz herangezogen.

1. Kalkboden ist auch dann noch als günstig für Waldbäume zu betrachten, wenn die Magnesiamenge relativ sehr gering ist ;
2. Die Bonität des Kalkbodens nimmt ab, wenn die Magnesiamenge beträchtlich die Kalkmenge überwiegt ;
3. Kalkmangel macht sich am auffälligsten bei der Kiefer durch Production kürzerer Nadeln bemerklich.

Ueber der Entstehung der Verkrümungen an Yotsuyamaruta.

(*Sugi*-Stangenholz)

VON

Dr. Seiroku Honda.

In der Umgebung von Tokyo besteht eine ausgedehnte *Sugi* Stangenholzwirthschaft von *Cryptomeria japonica*, japanisch: *Yotsuyamaruta*. Diese Bestände werden hier durch Pflanzungen von circa 80–100 cm. hohen Pflanzen, 6000–8800 pro ha, hergestellt, welche meist einmal verschult und 3–4 Jahre alt sind. Im fünften Jahre nach der Pflanzung wird Beastung gemacht, was je 2 Jahre später stärker wiederholt wird, um eine astreine Stange zu erziehen.

Da dieses Stangenholz meist schon im Alter von 12–20 Jahren gehauen wird, ist es von Wichtigkeit *geradschaftige* Stämme zu produciren. Allein in der Praxis bekommt man auffallend oft, durchschnittlich 60–70 %, am unteren Ende *gekrümmte* oder *gedrehte* Exemplare, so dass diese Krümmung oder Drehung die Verwendbarkeit der Stange im hohen Grade beeinträchtigt. Dieser Theil ist ungefähr ebenso lang, als die Pflanze bei der Umpflanzung gewesen war, nämlich 60–120 cm.[1] also im Durschnitt 90 cm. (Siehe Pl. XXXI).

Bei 16 jähriger Umtriebszeit liefert der Bestand pro ha. im Durchschnitt 221 Festmeter Holzmasse von 5000 Stück Stämmen. Da aber geradschaftiges Stangenholz mit 8 Meter Länge 10 *sen* (ca. 22 Pf.) kostet, gekrümmte aber nur mit 7 *sen* bezalt werden, so beträgt der Verlust pro ha. $5000 \times \frac{2}{3} \times 3 = 100$ *yen* (ca. 220 Mk.), somit *jährlich* pro ha. 6,25 *yen*, und da das *Yotsuyamaruta*-Gebiet um Tokyo allein schon ca. 10.000 ha. umfasst, entsteht im jährlicher Verlust von 62.500 *yen*.

Nun umfassen die *Sugi*-Waldungen im übrigen Japan eine Fläche von etwa eine Million ha. Man kann danach den

---

(1) Die Pflanzung im Walde darf nicht früher geschehen, weil kleinere Pflanzen, wie sie in Deutschland verwendet werden, hier durch die üppig aufschiessenden hohen Grasarten geschädigt würden.

enormen Verlust bemessen, wenn auch die vermehrte Nutzholzwirtschaft bei zunehmender Baumstärke den Verlust bei der Stangenholzwirthschaft einigermassen aufhebt.

Es schien mir desshalb wichtig, der Ursache jener Verkrümmung auf den Grund zu kommen und wenn möglich ein Verfahren zur Vermeidung derselben aufzufinden, was wohl nicht nur von wissenschaftlichem Interesse, sondern auch da nützlich sein dürfte, wo andere Holzarten zu geradeschaftigen Stangen gezogen werden sollen.

Was die Ursachen dieser Verkrümmung anbelangt, kann eben so wenig der Schnee als der Wind schuld sein; denn die Verkrümmungen finden nach verschiedenen Richtungen statt, fallen also mit einer bestimmten Windrichtung nicht zusammen. Zudem zeigten sich jene Abnormitäten auch an solchen Oertlichkeiten, welche gegen jeden Wind völlig geschützt sind (Siehe Pl. XXXI).

Es ist auffallend, dass überall da, wo der *Sugi*wald durch *Stecklinge* erzeugt wurde oder durch *natürliche Verjüngung* entstanden ist, die Verkrümmung gar nicht auftritt, wie z. B. auf der Insel Kiushiu, wo 50 cm. lange Aststangen 30 cm. tief in den Boden eingesetzt zu werden pflegen, oder in Akita-*ken* in Nord-Japan, wo man *Sugi*-Wälder mit *natürlicher Verjüngung* mit Fehmelschlagbetrieb findet, welche sämmtlich *gerade* Stämme liefern, während die dortigen künstlichen Pflanzungen wieder die verkrümmten Stämme aufweisen.

Es lässt sich somit vermuthen, dass man die Ursache jener Verkrümmung in der Pflanzung selbst zu suchen hat, also die Orientirung des Stammes hierbei vielleicht die Hauptrolle spielt. Um diese Vermuthung näher zu prüfen, habe ich mehrere Versuche angestellt, deren Resultate als vorläufige Mitteilung ich hiermit veröffentlichen möchte.

Fläche A :

Einjährige, noch nicht verschulte Pflanzen von 10 cm. Höhe wurden in 4 Reihen gepflanzt. Die erste Reihe enthielt Pflanzen von derselben Orientirung des Stammes, in der die Pflanzen gewachsen waren, so dass die Südseite des Stammes wieder nach Süden gerichtet wurde, während die zweite Reihe solche enthielt, welche in umgekehrter Stammorientirung gepflanzt

wurden, so dass also die frühere Südseite jetzt nach Norden gerichtet war. In der dritten und vierten Reihe befanden sich solche, die man um je 90° gedreht einsetzte, so dass bei der dritten die Südseite nach Ost und bei der vierten nach West gerichtet war. Die Entfernung der Reihen von einander betrug 20 cm. die Pflanzweite 18 cm.

Fläche B:

Diese wurde mit *dreijährigen*, aber einmal im ersten Jahre verschulten Pflanzen von 90 cm. Höhe in 8 Reihen zu je 20 Stück bepflanzt und zwar wurden hier dieselben Anordnungen wie oben eingehalten, wobei die ersten 2 Reihen die normal orientirten Pflanzen enthielten.

Die Reihenentfernung betrug 95 cm. und die Pflanzweite 90 cm.

Die beiden Flächen A und B hatten überall gleiche Bodenbeschaffenheit und Standortverhältnisse. Nach der Einpflanzung habe ich nur Gräser ausjäten lassen und zwar jährlich zweimal, nämlich im Frühsommer und Frühherbst. Sonst liess ich der Pflanzung keine weitere Pflege angedeihen.

Resultate:

Auf der Fläche A wuchsen die Pflanzen im ersten Jahre nach der Pflanzung ungefähr 17,5 cm. im zweiten um 62,7 cm. im dritten um 91 cm., die Höhe betrug also im Ganzen 149 cm. Während in der ersten Reihe fast alle Pflanzen gerade und nicht drehend wuchsen, zeigten die der zweiten Reihe fast alle Biegungen und Drehungen, als ob sie in ihre frühere Orientirung zurückstrebten. Einige wenige Pflanzen der ersten Reihe zeigten zwar Biegungen, aber keine Drehung, was bei der Bastbildung deutlich wahrgenommen werden konnte. Die Pflanzen der dritten und vierten Reihe zeigten die nämlichen Verkrümmungen und Drehungen wie in der zweiten. Pl. XXXII enthält die Photographie von einer Pflanze, welche diese Erscheinungen sehr auffällig zeigt (der Finger zeigt die Pflanzhöhe).

Auf der *Fläche B* wuchsen die Pflanzen in ersten Jahre nach der Pflanzung ungefähr um 20 cm. im zweiten Jahre um 48 cm.

im Dritten um 67 cm., es betrug also die gesammte Höhe 227 cm. Hier ergaben sich nun dieselben Wachsthumsverhältnisse wie bei A. Nur die Pflanzen mit beibehaltener Orientirung wuchsen geradschaftig und insbesondere kein Drehwuchs machte sich bei denselben bemerklich, während die Pflanzen mit *nicht normaler* Orientirung wieder Drehung und Biegung zeigten wie aus Pl. XXXII ersichtlich.

Meine Vermuthung, dass die Aenderung der Orientirung des Stammes beim Umpflanzen die Ursache der Biegungen und Drehungen sein könnte, hat sich demnach in unserem Falle bestätigt, und gibt uns die Vorschrift an die Hand, dass man, um geradschaftige Stangen zu erziehen, bei der *Umpflanzung* und in's besondere bei der *späteren Verschulung* junge Pflanzen in derselben Orientirung einzusetzen hat, in der sie gewachsen waren.

Ich bemerke nur noch, dass man jetzt leicht eine Erklärung für die bekannte Thatsache finden kann, dass Stecklingsbäume immer geradschaftig wachsen, da hierbei die Lichtseite des Astes immer nach Süden gerichtet gepflanzt zu werden pflegt.

Nachdem diese Mitteilung bereits dem Druck übergeben war, fand ich in der diesjährigen Augustnummer der forstlich-naturwissenschaftlichen Zeitschrift, herausgegeben von Dr. von *Tubeuf*, einen interessanten Artikel von Herrn Prof. *R. Hartig*, welcher die anatomischen Verhältnisse beim Drehwuchs der Kiefer behandelt. Ich beabsichtige, bei *Sugi* ähnliche Untersuchungen anzustellen.

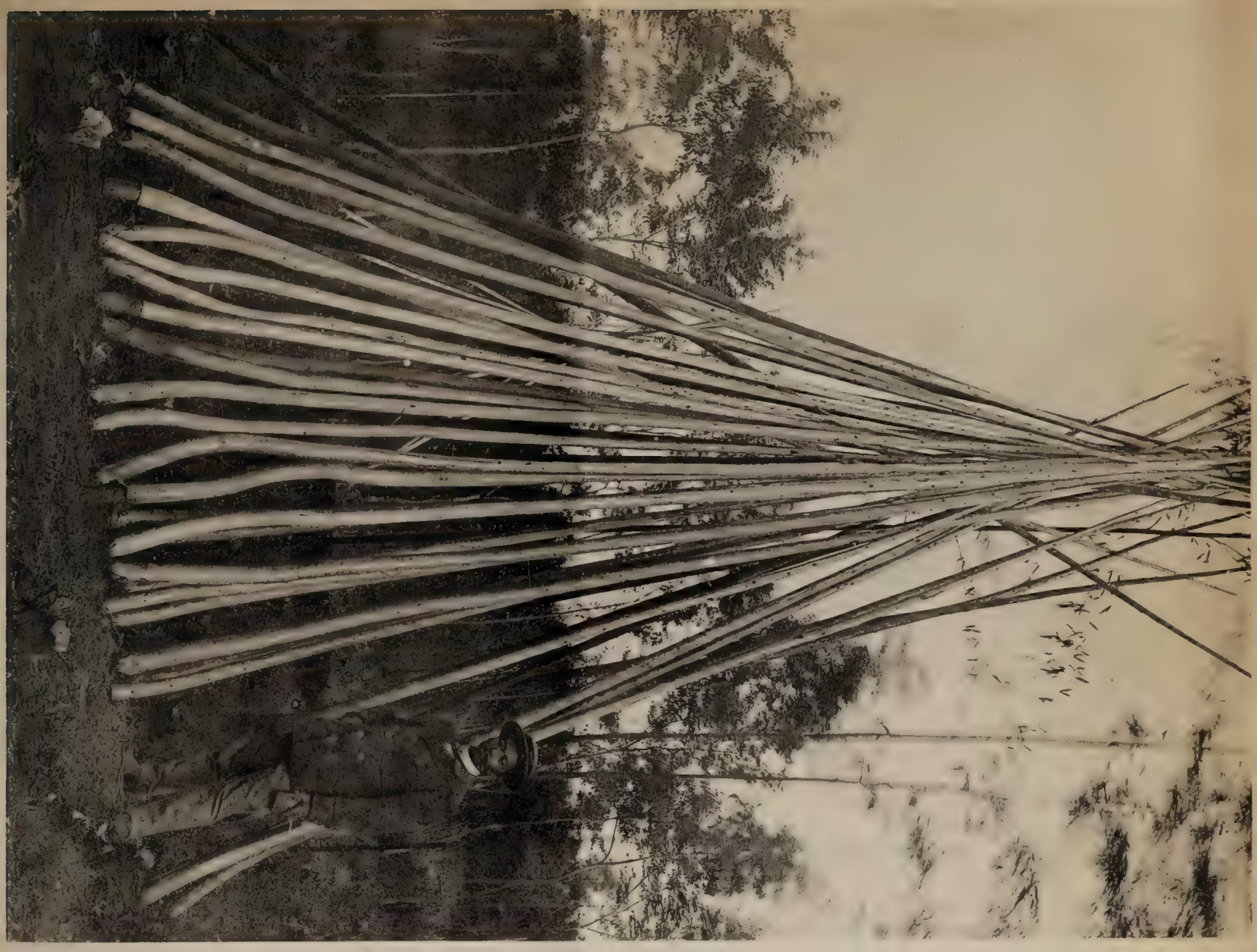

Fig. A.

Fig. B.

Fig. A.

Fig. B.

Anormal.

Normal.

Besitzen die Kiefernadeln ein mehrjähriges Wachstum?

VON

Dr. Seiroku Honda.

Während *G. Kraus* die Ansicht vertrat, dass ein mehrjähriges Wachstum der Kiefernadeln statt finde, nahm *R. Meissner* den Standpunkt ein, dass zwar die Nadeln in verschiedenen Jahrgängen eine verschiedene Länge erreichen, sowie am Haupt-, primären, und secundären Seitentrieb Unterschiede in der Länge zeigen, aber im zweiten Jahre nicht mehr zunehmen.

Da ich mehrere Exemplare von *Pinus longifolia* zur Verfügung hatte, deren Nadeln die aussergewöhnliche Länge von 50 cm. erreichen können und also zur Entscheidung jener Frage besser geeignet waren, als kleine Nadeln, nahm ich die Gelegenheit wahr, wiederholte Messung an jener Species und des Vergleiches wegen zugleich an *Pinus Korainsis* und *Pinus densiflora* vorzunehmen; Die Ergebnisse sind in folgender Tabelle zusammengestellt:

Jahr der Entwickelung.	Entwickelungszeit.	Baumteile der Entwickelung.	Länge der Nadeln.			Differenz von März-Oct.
			12 März.	9 Sept.	2 Oct.	
		I. *Pinus Longiforia.*				
1894	Spätsommer	Schaft (oberer Teil)	(14,20)	14,40	14,40	+0,20
,,	Sommer	,, (mittlerer Teil)	32,20	32,10	32,10	−0,10
,,	Frühjahr	,, (unterer Teil)	45,70	abgefallen		—
,,	,,	Zweige	43,60	43,60	43,70	+0,10
1893	,,	Schaft (oberer Teil)	40,60	40,60	40,60	0
,,	,,	,, (mittlerer Teil)	40,00	39,90	39,90	−0,10
,,	,,	,, (unterer Teil)	43,10	43,10	43,20	+0,10
		II. *Pinus Korainsis.*				
1894	Sommer	Schaft	8,90	8,90	8,90	0
,,	Frühjahr	,	12,60	12,60	12,60	0
1893	,,	,,	7,10	7,00	7,00	−0,10
1892	,,	Zweige	9,20	9,20	9,20	0
		III. *Pinus Densiflora.*				
1894	Spätsommer	Zweig (oberer Teil)	10,60	10,70	10,70	+0,10
,,	Sommer	,, (mittlerer Teil)	12,00	11,90	11,90	−0,10
,,	Frühjahr	,, (unterer Teil)	12,00	12,05	12,05	+0,05
1893	Spätsommer	Zweige	8,90	8,90	8,85	−0,05
1892	,,	,,	12,20	abgefallen		—

Da man beim Anblick eines vorjährigen Triebes sofort erkannte, dass die unteren Nadeln 2–3 mal länger sind, als die oberen, später entstandenen, so musste man selbstverständlich vermuthen, dass letztere im zweiten Jahre noch die Länge der ersteren erreichen würden, aber gross war mein Erstaunen, bei der Messung im zweiten Jahre zu finden, dass sie—*nicht* mehr zunahmen. Offenbar erreichen nur die im Frühjahre entstandenen Nadeln eine bedeutende Länge, nicht aber die später entstandenen; das Wachstum beider wird im Herbst abgeschlossen. Wir müssen also wohl *Meissner* Recht geben, wenn er das Wachstum der Nadel im zweiten Jahre bestreitet, müssen aber noch hinzufügen, dass nicht nur die Länge an Haupt- und Seitentrieb oder in verschiedenen Jahren wechselt, sondern auch sich Unterschiede an derselben Axe eines Triebes ergeben: die oberen bleiben kleiner als die unteren.(1)

(1) Die kleineren Nadeln, die im Spätjahr entwickelt werden, haben, wie ich mehrmals beobachtete, eine kürzere Lebensdauer, als die vollentwickelten; erstere fallen meist schon nach einem Jahre ab, wesshalb man an den älteren Baumteilen keine kleinen Nadeln mehr bemerkt, was zum Glauben verleiten könnte, sie seien noch gewachsen.

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Lability and Energy in Relation to Protoplasm.

BY

Dr. O. Loew, *Professor of Agricultural Chemistry.*

I have explained in former Bulletins[1] that physiological phenomena compel us to infer the existence of a *labile* (active) and a *stable* (passive) modification of albumin, and that the former alone,—as such and in the form of active nuclein —, is capable of leading by "organization" to living protoplasm, while the latter, or stable, modification would correspond to the condition of the albumin in dead protoplasm and to the reserve-albumin stored up in seeds and eggs. I have also described a highly *labile kind* of albumin, which is stored up as *reserve material* in the vacuoles and sometimes in the cytoplasm of living cells of various plants,[2] and which undergoes a chemical change under conditions that would kill living protoplasm.

I have further attempted to show that in regard to organic compounds, lability implies for the atoms in labile positions a distinct kind of energy consisting in continuous *atomic* motion which increases under the influence of heat, molecular motion passing here into atomic motion. Thus the cause of the respiration of protoplasm, and the utilisation of the heat of respiration for biological chemical functions of a katalytic nature, find a simple explanation. My incomplete treatment of lability, however, has called forth critical remarks[3] which induce me to offer some further remarks. The critic says among other things :

"That the *functions* of living matter are explicable in mechanical terms, physiologists of all schools alike admit. Dr. LOEW'S merit lies in his offering us a plausible explanation of the mechanical basis of *vital energy*, of that *activity* in which, as is well said by BUNGE (one of the foremost of the vitalistic school), "lies the riddle of life."

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(1) Bulletin, Vol. II, No. 2; No. 4.

(2) This remarkable substance was discovered by *Th. Bokorny* and myself. *Daikuhara* made further communications on the extent of its distribution through the vegetable kingdom (Vide Bulletin No. 2 and 4).

(3) Japan Mail, July 30 ; 1896.

"Let us turn to consider a difficulty in connection with Dr. LOEW'S hypothesis—a difficulty involved in the whole conception of *lability*. The difficulty will be best explained by a concrete example. "One of the most interesting labile atomic groups," says Dr. LOEW, "is the aldehyde group, $-C\begin{matrix}O\\H\end{matrix}$, in which the oxygen exerts an attracting influence upon the hydrogen connected with the carbon atom, this being generally tetravalent, but sometimes only bivalent. The hydrogen atom is thus ever oscillating between the carbon and the oxygen, as may be indicated by the following formulæ :—

$$-C\begin{matrix}O\\H\end{matrix} \quad (1) \qquad -C-O-H \quad (2) \qquad -C\begin{matrix}O\\H\end{matrix} \quad (3) \qquad -C-O-H \quad (4)$$

"The hydrogen atom may be conceived as oscillating between the carbon atom and the oxygen atom, as the contact-breaker of a faradic battery oscillates between the electro-magnet and the connecting point to the longer circuit. The defect in the analogy we have chosen serves to point the difficulty of which we have spoken. The oscillation of the contact-breaker depends on two forces that alternately become effective in opposite directions, the force of the electro-magnet overpowering the force of the spring, and the force of the spring when the electro-magnet has ceased to act. But can we find any similar play of alternating forces in our hypothetically constructed labile compound? It does not seem so. It is certain that the attractive force between two chemical atoms increases enormously as the distance between the atoms diminishes. Let us suppose our hydrogen atom to be placed initially between the oxygen atom and the carbon atom in such a manner that the pull is equal in both directions. If the hydrogen atom now moves in the direction of, say, the carbon atom, the attraction of the carbon atom at once becomes much greater than that of the oxygen atom, and the $-C\begin{matrix}O\\H\end{matrix}$ form should be permanently assumed.

"Does, then, Dr. LOEW conceive that in a labile group something takes place analogous to the changes in the faradic battery when the contact-breaker is vibrating? that the movement—to return to our example—of the hydrogen atom towards the carbon atom brings about a state of molecular forces within

the group whereby the opposite form of the group becomes preferable; and conversely, that when the hydrogen atom has moved back past the mean position and approximated itself to the oxygen atom, the opposite phase now becomes superiorily attractive? That would seem to be implied, for in that way only would be rendered possible the persistence in the group of an oscillatory movement whereby kinetic energy is preserved in the form of continuous atomic motion. But if that is Dr. LOEW'S view, he has not expressed it clearly; nor does he anywhere indicate his conception of the mechanism by which this changing play of the intramolecular forces may be supposed to be kept up. To return to our original rough analogy, unless something can be imagined more or less similar in its mode of working to the alternate play of electric and mechanical stresses in the faradic battery, the hypothesis of the oscillating atom in the labile group seems difficult to maintain."

I do not undervalue this criticism, for even specialists in molecular science have not yet penetrated the mysteries of lability of organic compounds. Thus, *Grant Allen* declares:[1] "Atomic motion may be separative as in decomposition, or aggregative as in the act of combining, the continuous or neutral stage is not at present known though there is reason to think that it exists." "Atomic motion is not known to have any continuous form analogous to the orbital motion of a planet, the spinning of a top, or the regular vibration of heat." *Ostwald* argues:[2] "Living organisms behave like katalytically acting substances.[3] The problem, however, of the mode of action of a katalytic substance is not yet solved. A start is made by the recognition that hydrogen ions can, in proportion to their number, accelerate certain reactions. It is physical chemistry to which we must look to throw a light upon the riddle of life." In a later article, however, *Ostwald* declares that katalytic actions could only be expected to receive explanation by new principles which lay beyond the laws of energy.[4] Before I enter upon a further

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(1) Force and Energy, Chapt. VI and VII.

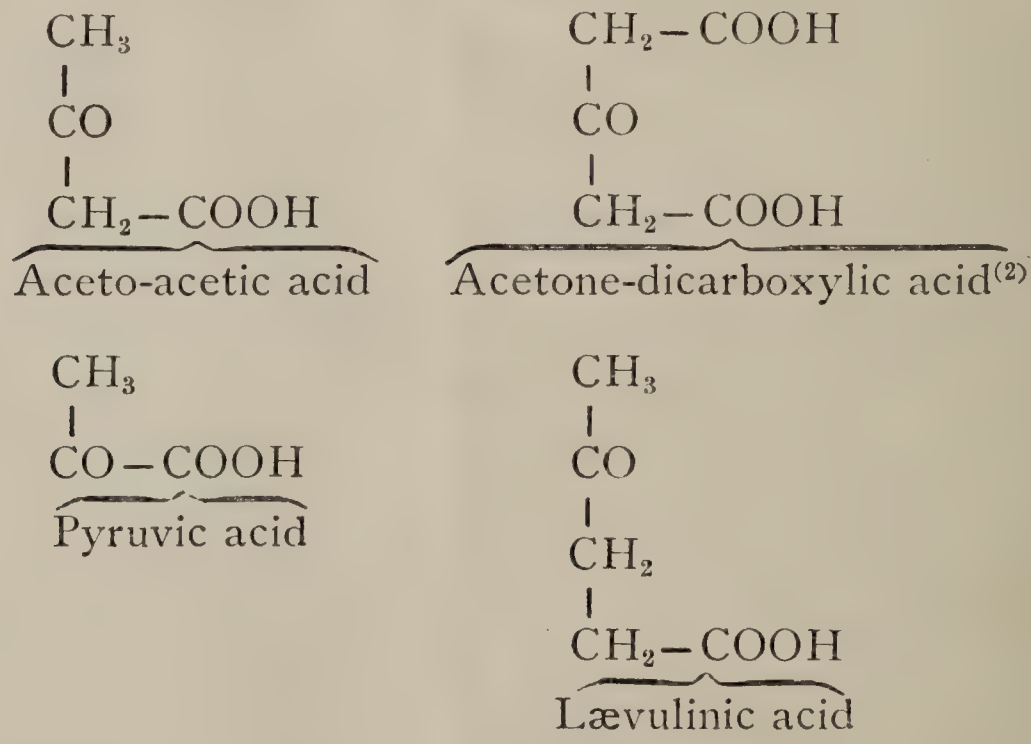
(2) Chem. Centr.-Bl. 1894 I. p. 4.

(3) This analogy was first recognised more than forty years ago by the physiologists *Ludwig* and *Lehmann*. Cf. *Lehmann*, Lehrb. der physiolog. Chem. 1853.

(4) Aula 1895, Nr. 1. To be sure, nothing can be more hopeless than to search for *Ostwald's "Neue Principien, welche über das Energiegesetz hinaus gehen!"*

discussion of the energy of aldehydes it may be worth while to give a series of cases which show how much various atomic groups and their relative positions can influence the stability of compounds which ranges within very wide limits.[1] While, *e.g.*, certain substances easily resist higher temperatures, as benzene and pyridine, others are decomposed by boiling water, as aceto-acetic acid ; others again change even at low temperatures, as cyanic acid or diamido-acetone.

As a general rule it may be considered that the *increase in number of hydroxyl or amido-groups, as also the alternation of positive and negative groups, depresses the degree of stability.* Glycerol is less stable then propyl alcohol ; di- and triamido-benzenes much less so than mono-amido-benzene *i.e.* aniline. Diketohexamethylene is less stable than dioxyhexamethylene (*Baeyer*), and acetoacetic acid less so than pyruvic or acetopropionic (lævulinic) acid ; but it becomes more stable by the introduction of one more carboxylic group.



The increase in number of carboxylic groups considerably diminishes the degree of stability in such cases in which two of these groups are linked to the same carbon atom. With the

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(1) In stable chemical compounds the atoms are placed in comparatively fixed positions relatively to each other and a change is not brought about except by relatively very energetic actions.

(2) The ratio of positive to negative groups is in aceto-acetic acid 2 : 2, while in acetone-dicarboxylic acid it is 2 : 3. This difference may account for the greater stability of the latter.

nitro-group, however, we observe a somewhat different behaviour in regard to the influence of position ; thus 1. 3 dinitropropane is much less stable than the isomeric 1. 1 or 2. 2 dinitropropanes.[1] The stability of a compound against chemical attacks grows with the increase of the number of the CH_2 or alkyl groups. Thus, formaldehyde enters much more easily into various reactions than its homologues ; acetone dicarboxylic ether is no longer attacked by phenylhydrazine after *two* methyl groups have been introduced and it even resists the action of phosphorus pentachloride after *four* methyl groups have entered.[2] Also the relative position exerts an influence ; thus, a methyl group in para-position in diazobenzene leads to a greater stability than one in ortho-position.[3] The 1. 3 keto-aldehydes of the form $R-CO-CH_2-CHO$ are very unstable and undergo spontaneous condensation, while after the introduction of a second alkylic radical in α-position, a product $R-CO-CHR'-CHO$ results that may even be distilled unchanged.[4] On the other hand we must not omit an exception observed with diazo-propionic ether, which is less stable than diazo-acetic ether.[5]

Diazo-acetic ether Diazo-propionic ether

The readiness with which an atom is replaced by another atom or by a radical, may, *ceteris paribus*, be considered as a *measure of the lability of its position.* Thus, the hydrogen atoms in α-position to a keto or carboxylic group show a higher degree of lability than those in β or γ-position,[6] but still more labile are generally the hydrogen atoms of the *amido-group.*[7]

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(1) *V. Meyer*, Ber. Chem. Ges. **25**, 1709.

(2) *Petrenko*, Chemikerzeitung, 1895, p. 1880.

(3) *Hirsch*, Ber. Chem. Ges. **24**, 325.

(4) *Claisen*, Bayr. Akad. Ber. 1890 p. 447.

(5) *Curtius*, Ber. Chem. Ges. **23**, 3037.

(6) Very numerous are the observations on varying lability of hydrogen atoms and their substitutes in the benzene ring. Hydrogen atoms in a high degree of lability are easily attracting atomospheric oxygen (autoxidations). By the vicinity of negative groups as cyanogen, phenyl or carboxethyl, certain hydrogen atoms attached to carbon can acquire in special cases the property of being easily replaced by metals; this state, however, is not a genuine case of lability.

(7) Also the *cyanogen* group linked to nitrogen is more labile than when linked to carbon (Ber. **28**, 2074).

But not only does the lability of these *hydrogen atoms* vary considerably in different compounds, that of the *entire amido-group* also does so, and the latter is, in some cases, easily split off as ammonia, as in the case of diacetone-amine, or the pinylamine of *Wallach*, and in other cases is readily replaced by hydroxyl, as in the amides of acids. Of the γ-amido-acids the amido-group is also said to be easily removed with the formation of lactones.[1] The *relative position* of the amido-group also exerts a powerful influence upon the special character of a compound; thus ortho and para-amido phenol are stronger bases than aniline, while meta-amidophenol is a weaker one, than aniline.[2]

Of special interest is the *transition of a labile compound into a stable modification.* In certain cases the latter can easily be retransformed into the former, in others it is difficult. Of nitro-para-aceto-toluide a yellow and a colourless modification exist; the former is more stable at a high temperature than the latter but can easily be retransformed into it.[3] The oxime of oxynaphthoquinone-imide exists in two forms, a red one, stable in alkaline solution; and a light yellow one, stable only in acid solution.[4]

Claisen[5] infers from his investigations on 1. 3 diketones that some of them may exist in two modifications, viz., as . C(OH) : C · CO . and . CO · CH · CO . "It depends upon the nature of the attached radicals, the temperature, the nature of the solvent, which of the two forms is the more stable under the conditions present." Two isomeric forms of the formyl-phenyl-acetic ether have been isolated which can easily pass one into the other, the liquid or α-modification corresponds to the enol (hydroxyl-) structure, the solid or β-modification to the aldo-structure.[6] The former which alone gives a blue violet

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(1) Ber. Chem, Ges. **17,** 203. The replacement of an alcoholic hydroxyl group by an amido-group is only in certain cases easily accomplished, as in cyanhydrines, in nitrosonaphthol (Ber. **17,** 393) and in the ortho-nitro-derivative of the phenyl-β-oxypropionic acid (*Einhorn*, Ber. **16**, pp. 2645 and 2651). Evidently the influence of a negative group is required for enabling such an exchange.

(2) *Lellmann* and *Gross*, Ber. Chem. Ges. **24,** R. 107.

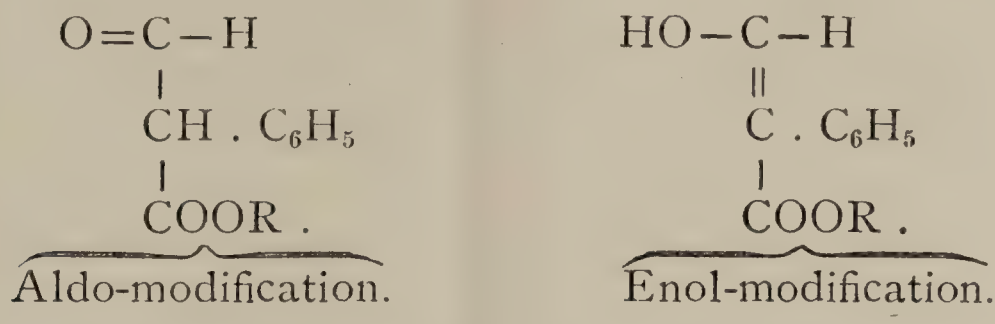
(3) *Gattermann*, Ber. Chem. Ges. **23,** 1733.

(4) *Kellermann* and *Hertz*, Ber. Chem. Ges. **29,** 1145.

(5) Ibid. **29,** R. 499.

(6) *Wislicenus*, Ibid. **29,** R. 503. *Brühl*, Ibid. R. 484. In this case the aldo-modification has a decidedly acid character, while in the above mentioned case of *Claisen* it is the enol-modification.

reaction with ferric chloride, is the more stable modification at higher temperature and occupies a smaller molecular volume (*J. Traube*, 1896). In alcoholic solution the aldo-modification is gradually produced while in chloroform the enol-modification is preserved.



J. Traube also has shown the probability of the existence of two isomeric forms of aceto-acetic ether, each of which very easily can pass into the other.[1] Labile compounds, however, often undergo such changes that reversion to the original substance either requires the expenditure of a considerable amount of energy, as in cases of polymerisation, or has become entirely impossible, since the chemical structure has been altered too much, as, *e.g.*, when amides are formed from oximes, or when ortho nitro-benzene compounds change, by atomic migration, into amido-compounds, the lateral chain exchanging a portion of its hydrogen against the oxygen of the nitro-group.[2] Also the changes which amido-acetone and amido-ethyl aldehyde undergo spontaneously under *ordinary* conditions, when liberated from their compounds with acids, belong to this group of phenomena.[3]

To give in all these cases a satisfactory explanation of the degree of lability is not an easy matter, for want of clear conceptions of chemical affinity and chemical energy. *Ostwald*[4]

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(1) Ber. Chem. Ges. **29**, 1715. The observations of *Friedlœnder*, *Gœhring*, *Knorr* and others had already shown that this ether can react in two distinct ways.

(2) The rule that oxygen connected with nitrogen in a compound can easily migrate to carbon, but can never do so in the opposite direction, is easily explained on general chemical principles.

(3) Of further examples may be mentioned: By treatment with alkaline solutions phenylazoxazol changes into the isomeric oxime of benzoyl cyanide (*Russanow*); the closely related 'furazan carboxylic' acid into cyan-nitroso-acetic acid (*Wolff* and *Gans*; Ber. 24), and α-methylisoxazol into cyan-acetone (*Claisen*; ibid. **25**). Isodiazo-naphthalin isolated from its sodium combination changes at once into ordinary diazonaphthalin (*Bamberger*; ibid. **27**). Phenyl hydroxylamine changes in contact with acids into-para-amidophenol, and the nitrosamine of that compound changes spontaneously after some time (*Bamberger*; ibid. **27**).

(4) Outlines of General Chemistry, p. 208.

writes : "Chemical energy is to us the least known of all the various forms of energy, as we can measure neither it nor any of its factors directly. The only means of obtaining information regarding it, is to transform it into another species of energy. It passes most easily and completely into heat." Later on[1] he declares : "Chemical energy can be separated into two factors, intensity and capacity. The doctrine of the intensity of chemical energy embraces a large part of those phenomena that were called affinity."

I have adopted the definitions of *Grant Allen* (l. c.) : "Chemical *affinity* is the force that aggregates atoms, chemical *energy* is motion which separates atoms and resists the aggregation of atoms." "Force and Energy, the aggregative and the separative powers are incessantly opposing and antagonising one another in all bodies, great or small. The amount of aggregation reached by any system at any point of time depends upon the relative proportions of its forces and its energies at that moment."

This holds good also for the complicated molecules of organic chemistry. In a very stable compound, the *force* of *affinity* between its atoms preponderates, and only a small amount of energy is present.[2] On the other hand, *substances that very easily enter into reactions can hold their components only loosely bound*, and the force of affinity is here counteracted by *chemical energy*. Atoms are in an unstable equilibrium when a minute amount of work suffices to lead to an alteration in the system ; such atoms have chemical energy.

But we must carefully distinguish between *several kinds of instability*. There evidently exist substances, certain atoms of which merely possess *potential chemical energy* relatively to the other atoms in the same molecule, as in the case of oximes and nitro-compounds where the oxygen linked to nitrogen possesses "energy of position" with respect to the carbon atoms. In certain other cases, however, atoms may possess, with respect to others in the same body, *kinetic chemical energy*, being in a continuous vibrating motion. But doubtless, there are also

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(1) Chem, Central-Bl. 1894. 1. p. 4.

(2) The compounds are, of course, here considered merely with regard to their chemical structure, *i.e.* to the relative position of their own atoms ; not in their relation to other bodies. Everybody knows, *e. g.*, that in relation to free oxygen *all organic substances* contain potential energy.

compounds in which both modes of energy exist at the same time.

Compounds in which much potential chemical energy is accumulated, capable of being suddenly liberated, are the explosives. Such cases of instability have no particular interest in connection with our special case. The instability I have in view, is the state of lability caused by atoms kept in a fierce state of vibration, which tend, therefore, to enter into numerous reactions. That such labile compounds possess energy of the *kinetic* kind, becomes manifest from the fact that certain such compounds can, by imparting their atomic motion to other distinct compounds, cause certain chemical changes, without changing themselves in any equivalent measure (katalysis). I have mentioned as examples in a former Bulletin (No. 4) the katalytic action of maleic acid upon ketazines, of ethaldehyde upon free cyanogen, of ethyl nitrite upon thio-urea, and the actions of the enzymes.[1]

When a labile substance passes into a stable isomeric one, its kinetic chemical energy either diminishes or wholly disappears, and assumes, in equivalent ratio, the form of molecular motion, *i.e., heat.* In this transformation the molecular volume decreases, while the melting and boiling points are raised. This is an interesting fact, and in full accordance with *Stohmann's* observations ; for the labile compounds have a greater thermic value than the isomeric stable ones.[2]

Atomic motion of the hydrogen atoms in benzene has been supposed by *Kekulé* to account for the existence of only one modification of ortho-compounds, and by *Laar*[3] for the hydrogen atoms in tautomeric (absolute pseudomeric) compounds, to ex-

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(1) We must always keep in mind that heat, *i. e.*, molecular motion can *under certain conditions* easily pass into atomic motion, and that the atmosphere is an immense storehouse of heat energy ; thus the continuity of katalytic action is easily explained in such cases where an exhaustion of energy would seemingly have to be expected.

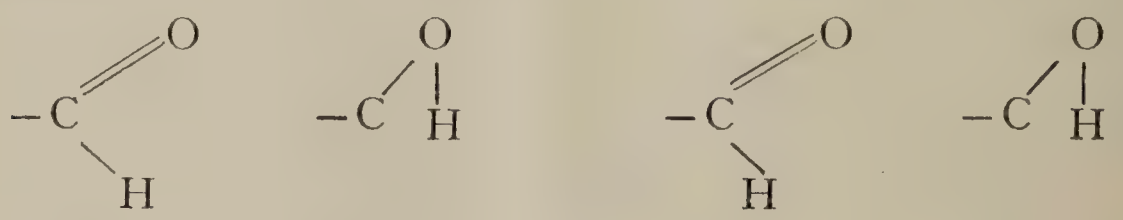
(2) Journ. f. prakt. Chem. **46,** 530. There seem to exist exceptions in which the larger molecular volume is not coinciding with the larger thermic value, as *e.g.*, a comparison of aldehydes with the isomeric alkylene oxides would indicate (Ber. Chem. Ges. **24,** 652). But we must keep in mind that we have in this case two compounds of considerable difference in character before us, which stand to each other by no means in such a relation as we have under consideration.

(3) The hypothesis of *Laar* has recently been declared improbable by *Traube* (Ber. Chem. Ges. **29,** 1723), while *Kekule's* view has,—at least to a certain extent—, been replaced by that of *Baeyer.*

plain their ability to react in two different ways; but both these authors have failed to explain how the continuity of these oscillations is kept up.

How, then, can the *lability* of *aldehydes* be explained by a continuous atomic motion? The mechanism is in all probability as follows: In the first place there is the hydrogen of the aldehyde group attracted from two sides, that of the oxygen and that of the carbon, the attraction of the former being, under the given conditions, a little superior to that of the latter.

In the second place, the *oxygen atom moves closer* to the *carbon atom* as soon as the doubly linked state in the aldehyde group (a) has passed into the simply linked state (b) of the hydroxyl group.[1] This sudden motion of the oxygen atom influences of course also the attached hydrogen atom, whose vibrations in conjunction with the two free valencies of the carbon atom, bring it again close to the carbon. At this moment the oxygen becomes again doubly linked and moves off into greater distance, and the former play commences anew. The condition, therefore, which the above mentioned critic believes to be missing, is actually present, namely: when the hydrogen atom has moved back, passed the mean position, and approximated itself to the oxygen atom, the opposite phase becomes superiorily attractive.[2] Both, the hydrogen atom and the oxygen atom are continuously in a fierce state of vibration, as may be indicated by the following formulæ:



The lability, *i.e.* the kinetic chemical energy in an aldehyde group, under certain conditions, may reach a much higher intensity. Such a condition is, *e.g.*, the presence of an amido-group in the same molecule. The continuously moving oxygen

(1) Oxygen, in the form of hydroxyl occupies a volume of 2.3; while in the carbonyl form one of 5.5. Also doubly linked carbon atoms have a larger molecular volume (and higher thermic value) than simply linked ones.

(2) Attention may here be called to the inference drawn by *Thomson* (Ber. **19**, R. 76) from thermo-chemical observations, that aldehydes behave in certain points like compounds containing a hydroxyl-group besides unsaturated carbon; this would correspond to the phase (b) of our inference drawn from a very different contemplation.

atom of the aldehyde group sets the hydrogen atoms of the *amido-group* into rapid motion, as,—to give a rough analogy—a moving magnet held beneath a sheet of paper moves iron particles spread upon the sheet, which cannot unite with the magnet, the sheet holding them back. These moving hydrogen atoms of the amido-group, again, will exert an influence upon the labile hydrogen atom in the aldehyde group which, in consequence of the repulsion it suffers, is compelled to increase the amplitude of its oscillations.[1] Thus we can understand why the lability of an amido-aldehyde is very great and the inclination to spontaneous changes much more marked than with common aldehydes. The degree of lability, however, is much influenced by the more or less saturated condition of the compound, the relative position of the labile atoms, and the relative number of the CH_2-groups. Thus, amido-ethylaldehyde is much more labile than the δ-amido-valeraldehyde; the latter remaining even unchanged on distillation under diminished pressure, while the former changes soon after it is liberated from its combination with acids. The amido-benzaldehydes, again, are less labile, although reacting with great readiness and readily changing when brought in contact with dilute hydrochloric acid.

Such a state of kinetic chemical energy was foreseen by me to exist in the active albumin, which I consider a product of the condensation of the di-aldehyde of aspartic acid (cf. Bulletin II. No. 2). The active group α which, by atomic migration, easily passes into the passive group β, would, according to my deduction, have the following structure:

$$\underbrace{\begin{matrix} -CH-NH_2 \\ | \\ =C-CHO \end{matrix}}_{\alpha} \qquad \underbrace{\begin{matrix} -CH-NH \\ | \quad / \\ =C-CHOH \end{matrix}}_{\beta}$$

Aldo-amido-structure. Hydroxyl-imido-structure.

The one essential to my theory is the constitution of the labile (active) group and the conclusion that the active albumin is a product of the condensation of aspartic aldehyde, which may be built up in the living plant cells of formaldehyde and ammonia; a

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(1) Hydrogen atoms of a high degree of lability behave sometimes somewhat like nascent hydrogen, leading to powerful reductions.

non essential is the supposed relative number of the active groups (twelve for *Licberkuehn's* formula), as unforeseen atomic migrations may occur. Compounds with more than two aldehyde groups[1] have not thus far been prepared but this fact in itself gives no ground to infer that molecules with more than two aldehyde groups are impossible. The actual preparation of a compound consisting of six keto-groups, *viz.*, the triquinoyl, appears in itself hardly more striking than, *e.g.*, that of a benzene-ring would be to which six aldehyde groups are attached, corresponding to the as yet hypothetical aldehyde of mellitic acid.

When, in the year 1880, I explained before the *Munich Chemical Society* my theory of the formation of albumin in plants, and I had expressed the opinion that amido-aldehydes, an unknown class of bodies then, would certainly be prepared at a future time, some of the chemists present denied the possible existence of such bodies, as they would change at the moment of preparation. Later, however, amido-aldehydes were prepared, and it was found that the degree of lability varies considerably with different amido-aldehydes. Moreover, the toxicological facts described (Bulletin II. No. 1), give colour to my deduction that the lability of the living protoplasm is caused by the co-existence of aldehyde and amido-groups in the active albumin.

To recapitulate : Labile (kineto-labile) compounds, which readily change into an isomeric stable modification contain certain atoms loosely bound, which condition is caused by a certain amount of kinetic chemical energy counteracting the force of affinity existing between the atoms of the compound. Every energy of the kinetic kind is motion, and motion can be conveyed from one body to another. Kinetic chemical energy (atomic motion) may, by being conveyed to atoms of other easily changeable compounds, lead to chemical changes in them (katalytic phenomena). I have attempted to give an explanation of the *continuity* of such motions in aldehyde groups, according to our present state of knowledge. But even those who may consider that *explanation* still incomplete will at least admit the correctness of the deduction that labile atoms are in a special state of continuous vibration.

For his convenience, the reader may now follow a juxtaposition of inferences of my theory and of actual observations :

[(1) Cf. On phthalic aldehyde, Ber. Chem. Ges. **20,** 509.

Theory.	*Facts.*
1. Albumin is formed by condensation of the still hypothetical aspartic aldehyde which in plant cells either is produced from asparagine or built up of form-aldehyde and ammonia.	1. There exist intimate physiological relations between asparagine and albumin; the former is an excellent material for building up the latter. The formation of albumin often takes place with great rapidity.
2. There is a chemical difference between the *albumin* of the living and that of the dead protoplasm.	2. The living protoplasm shows a chemical behaviour totally different from that of the dead.
3. The labile, active albumin leads by organization to living matter, as such and in the form of nuclein and nucleo-albumin.	3. There frequently occurs, as reserve-material, in plants a highly labile kind of albumin of aldehyde character, whose chemical nature is altered by the same influences, as those by which the protoplasm is killed.
4. The lability of the albumin of the living protoplasm is caused by the presence of aldehyde and amido-groups.	4. Compounds which react upon aldehydes, and such as react upon labile amido-groups with great energy, are poisons for all organisms.
5. The conversion of the albumin of the living to that of the dead protoplasm, presents a remarkable analogy to the change of a labile substance into a stable modification.	5. The transition of living protoplasm into dead is accompanied by contraction and development of heat.

The unbiassed reader will perhaps find here some coincidence between theory and facts.[1]

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(1) A full account of theoretical views and actual observations is contained in my treatise: *The Energy of Living Protoplasm*, London, 1896; *Kegan Paul, Trench, Trübner* & Co.

On the Formation of Mannan in Amorphophallus Konjak.

BY

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In regard to the formation of carbohydrates, *Amorphophallus konjak* is of special chemical interest. The *tuber* of this araceous plant, from which different articles of food are prepared in Japan, contains, as *Tsuji*[1] has shown, no starch, but a very large proportion of mannan. Afterwards *Kinoshita*[2] found that the tuber contains two mannans, a slimy soluble one and another insoluble in water. The question suggested itself to my mind : is this *mannan* produced from *glucose* by transformation in the *tuber*, or is the soluble mannan already formed in the *leaves* from glucose, or finally is mannose a direct product of the assimilation of carbonic acid in the place of glucose in this plant ? Thus far, mannose has never been found in plants except in the form of anhydrides, and it would be no doubt of great physiological interest if it could be shown that there exist chlorophyll bodies which produce mannose instead of glucose.

I examined, therefore, the leaf of this plant and found but very little starch,[3] besides globules not coloured by iodine, and raphides. Further I observed that *all portions of the leaf*[4] contain a very slimy substance which proved to be an anhydride of mannose. The extract prepared with warm water (40°–50° C) was mixed with a large proportion of alcohol and the resulting flocculent precipitate was purified by again dissolving it in water and precipitating once more with alcohol. The aqueous solution

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(1) This Bulletin, vol. II., No. 2. (1894).

(2) This Bulletin, vol. II., No. 4. (1895).

(3) I have examined small fragments of the leaf-blade, collected one clear sunny afternoon, with iodine solution under the microscope and found but very few granules were coloured blue. In the ribs there was also only a small amount of starch but relatively more than in the blade-cells. The cellulose walls in the blade gave the *ordinary cellulose reaction* with sulphuric acid and iodine.

(4) The leaf stalk and larger portions of the ribs were separated from the leaf-blade, including smaller ribs, and both were separately investigated.

of this precipitate had a slimy consistency, and showed the interesting property of *losing* its *slimy* character on prolonged boiling, whereby the slimy compound separated as *insoluble flocculi*. The freshly prepared solution of the mucilage yields a white flocculent precipitate with basic lead acetate upon the addition of some ammonia, and a thick blue precipitate with either *Fehling's* solution or copper sulphate solution in presence of sodium hydrate. On boiling with dilute sulphuric acid of 3 % the mucilage was, after a few hours, transformed into a sugar, which, after the removal of the sulphuric acid by barium carbonate and evaporation of the filtrate, at once yielded, on the addition of phenyl-hydrazine acetate, the characteristic precipitate of mannose-phenylhydrazone.(1) To test whether galactans or pentosans were present in stalk and blade, the residue, which remained after the extraction of several hundred grams with alcohol and warm water, was boiled for several hours with dilute sulphuric acid of 4 %. The syrup obtained after neutralizing with barium carbonate and evaporating, was tested for the presence of pentose with phloroglucin and hydrochloric acid, and for galactose by evaporation with nitric acid, but neither a pentose reaction nor mucic acid were obtained ; therefore *neither pentosans nor galactans were present*. Only a little mannose was obtained from this insoluble part.

The question whether *mannose as such* is *present* in the stalk and blade I tried to answer by extracting these objects with alcohol of 50 % whereby the mannans would remain insoluble, while the sugar would be dissolved. These extracts were evaporated,(2) dissolved in a little water, and basic lead acetate added to remove tannin and other impurities. The filtrate freed from lead with hydrogen sulphide was evaporated after neutralization with sodium carbonate. Upon the addition of phenylhydrazine acetate, only the extract of the stalk yielded a sufficient quantity of the precipitate of mannose-phenylhydrazone, while there was a doubtful trace in the case of the extract of the blade. The filtrate of the above precipitate yielded, upon further addition of phenylhydrazine acetate and heating on the water bath, such a

(1) This mucilage of the stalk and blade agrees therefore in its essential properties with the soluble mannan which *Kinoshita* obtained from the *tuber* (loc. cit.).

(2) Since in the case of the stalk an acid reaction of the extract was noticed, it was neutralised with sodium carbonate.

considerable quantity of phenylglucosazone that I must conclude, there was present in the stalk, besides mannose, glucose or fructose,[1] or both to some extent.[2] The mannose-phenylhydrazone first obtained was recrystallized and showed the proper melting point of 195° C and the characteristic tabular crystalline forms. It was, like pure mannose-phenylhydrazone, hardly soluble in absolute alcohol and warm acetone, almost insoluble in ether and benzene, and reduced *Fehling's* solution very strongly upon warming.

The fact that the slimy mannan is present in the cells of the *leaf* makes it highly probable that it plays to some extent the role of *starch* in this plant, but whether mannose is really the first product of assimilation, can not yet be answered. I hope however to settle this question by further investigations. On the other hand, the *presence of mannose as such in the stalk is evidently of high physiological interest as this is the first time that it has been found as such in plants.* I am indebted to my most honoured former teacher, Dr. OSCAR LOEW, Professor in the Imperial University, for kind suggestions.

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(1) A portion of the above syrup obtained from the extract of the stalk was tested for fructose with resorcin and concentrated hydrochloric acid, whereby a cherry red colouration resulted. Another portion of the syrup was treated with a mixture of ether and alcohol; on evaporation of the extract I obtained the proper red colouration with the above reagent. It is therefore, probable that some fructose was present in the stalk.

(2) *C. A. Lobry de Bruyn* (Rec. Trav. Chim. 14 (1895) 201-206 and Ber. Chem. Ges. 28 (1895) 3078-3082) has recently discovered the highly interesting fact, that by simply treating with alkalies these three sugars can be transformed into one another.

On the Formation of Asparagine in Plants under Different Conditions.

BY

U. Suzuki, *Nōgakushi.*

Although the question of asparagine production in plants has often been the object of investigation, many points are still left unsettled, and in certain respects, even contradictory statements, not only in regard to its production, but also in regard to its transformation into proteids, are met with. The production of asparagine from proteids during the germination process has been quantitatively followed up by E. SCHULZE, but thus far, all the explanations attempted have proved unsatisfactory ; therefore Dr. O. LOEW has proposed a new view which seems to accord better with various facts.[1] According to this view asparagine is a synthetical product, into which the ammonia of the decomposed proteids is transformed. Recently some experiments have been made by Mr. KINOSHITA in the laboratory of the Agricultural College, Imperial University, which show that the ammonia taken up by the roots may also pass into asparagine ; but as these experiments were made with only two kinds of *Gramineæ* it appeared to me necessary, in view of the importance of the question, to carry out a larger number of experiments, to test whether this transformation takes place in different families and in different states of development. Furthermore, I desired to compare quantitatively the asparagine production from different ammonium salts[2] and from nitrates, and to determine how the results are affected by the increase of sugar. These experiments are described in the following pages, while the analytical data follow in an appendix.

I. Experiments with sun-flower *(Helianthus annuus).*

The young sun-flower plants, 30–40$^{c.m.}$ high, were taken very carefully from the field, and after washing the roots, placed in the following solutions kept in a glass house :

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(1) Cf. The Energy of Living Protoplasm, London, 1896. p. 38.

(2) In some cases I also applied urea.

a, 0.1 % solution of ammonium nitrate.
b, ,, ,, ,, ammonium chloride.
c, 0.2 % ,, ,, sodium nitrate.
d, distilled water.

Time :—8 days. (Oct. 27—Nov. 4.)
Temperature :—Min. 10.5°C. ; Max. 40°C.

Neither the solutions of sodium nitrate, nor the plants grown in the different solutions, gave any reaction for ammonia ; only a few leaves withered during the experiments, and these were removed. The result of the analysis was as follows.

Table I :—In 100 parts of dry matter :

	Original[1] plants (Oct. 27th)	Control[2] plants (Nov. 4th)	Plants in Ammonium nitrate	Ammonium chloride	Sodium nitrate
Asparagine nitrogen	0.14	0.29	0.78	0.99	0.39
Asparagine[3]	0.64	1.38	3.67	4.67	1.85

This result shows that ammonium chloride produced much more asparagine than ammonium nitrate, and this again double as much as sodium nitrate, while an increase of asparagine in the control case, compared with the original plants, taken from the field, must evidently be due to the gradual transformation of nitrates that had been stored up in the stem and roots, whose presence had been shown by the diphenyl-amine test.

II. Experiments with yellow-lupine (*Lupinus luteus*).

Young plants 20[c.m.] high were taken from the field ; 4–6 plants were placed in 300[c.c.] of the following solutions :—

a, 0.1 % solution of urea.
b, ,, ,, ,, ammonium phosphate.
c, 0.2 % ,, ,, sodium nitrate.
d, distilled water.

and kept in the glass house for 6 days, from Nov. 7th to 13th.

Temperature :—Min. 8°C. ; Max. 35°C.
After drying, the entire plants were used for analysis.
Table II :—In 100 parts of dry matter.

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(1) "Original" means the plants which were analyzed at the beginning of the experiments.

(2) "Control" means the plants kept in distilled water.

(3) The water of crystallization of asparagine is not included in these calculations.

	Original plants (Nov. 7)	Control plants (Nov. 13)	Plants in Ammonium phosphate	Urea[1]	Sodium nitrate
Asparagine nitrogen	0.38	0.40	0.62	1.18	0.72
Asparagine	1.76	1.91	2.90	5.55	3.35

It is to be remarked in this case that urea, which might have been transformed into ammonium carbonate in the plants, was much more favourable than sodium nitrate for asparagine production, while the ammonium phosphate was less favourable than sodium nitrate.

III. Experiments with "sendan" (*Melia Japonica*).

The young branches of this plant were put into flasks containing about 250$^{c.c.}$ of the following solutions :—

a, 0.1 % solution of ammonium chloride.
b, ,, ,, ,, ammonium phosphate.
c, 0.2 % ,, ,, sodium nitrate.
d, distilled water

and kept in the glass house for 6 days (Nov. 7—Nov. 13).[2]

Temperature :—Min. 8°C. ; Max. 35°C.

After drying, the leaves and 20$^{c.m.}$ of the upper parts of the stems were analyzed.

Table III :—In 100 parts of dry matter :

	Original plants	Control plants	Plants in Ammonium chloride	Ammonium phosphate	Sodium nitrate
Asparagine nitrogen	0.11	0.13	0.37	0.29	0.27
Asparagine	0.52	0.59	1.76	1.38	1.25

IV. Experiments with squash (*Cucurbita melo peppo*).

Squash seeds were distributed in three large pots containing sea sand washed first with hydrochloric acid, then with common soft water ; the pots were kept in the glass house, in which the temperature ranged from 22°C. to 44°C. Four days after sowing, the germination had fairly set in, and when 3$^{c.m.}$ high, the shoots of one pot were treated with 0.05 % solution of ammonium nitrate,

(1) The nourishing solutions did not show any development of bacteria ; the plants remained healthy. About $^1/_8$ of the total urea of the solution was here transformed into asparagine.

(2) At the end of the experiments the plants began to suffer, the temperature having been too high.

of the second with 0.1% solution of sodium nitrate, while those of the third served as a control case. Ten days after the treatment, the plants were removed from the seed bed,(1) dried, and only the stems and roots used for analysis, because it has been found by others that cotyledons and leaves always store up less asparagine than stems and roots.

Average height of the control plants(2)	13.3 c.m.
,, ,, plants in ammonium nitrate	10.1 c.m.
,, ,, plants in sodium nitrate	6.3 c.m.
Average fresh weight of control plants	2.36 grams.
,, ,, ,, of the plant in ammonium nitrate	1.79 grams.
,, ,, ,, of the plant in sodium nitrate	1.20 grams.

The total ammonium nitrate solution applied was 318 c.c. = 0.0557 gram nitrogen.

The total sodium nitrate solution applied was 322 c.c. = 0.053 gram nitrogen.

The aqueous extract of a portion of these plants did not show a trace of ammonia, while the reaction for nitrates was obtained in the plants in ammonium nitrate and sodium nitrate with *Knop's* solution.

Table IV :—In 100 parts of dry matter free from ash.

	Control plants	Plants in Ammonium nitrate	Plants in Sodium nitrate
Albuminoid nitrogen	2.49	2.58	2.53
Proteids	15.59	16.13	15.83
Asparagine nitrogen	1.38	3.94	3.33
Asparagine	6.53	18.57	15.69(3)

The same experiment was repeated later in the autumn with shoots a little more developed than in the first case.

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(1) Some of the plants had been attacked by a fungus, *Fusarium Lateritium*, especially in the lower parts of the stems, and in the cotyledons; such plants were, of course, discarded.

(2) The better growth of the control plants in this case is evidently due to the very early stage of the shoots, which contained a large quantity of soluble nutrients from the cotyledons. Thus an increase of soluble nutrients had a retarding effect. In a 10 % cane sugar solution, e.g , young plants will not develope so well as in one of 1 % only.

(3) The cause of the considerable production of asparagine from nitrates may in this case be due to the high temperature, favouring the reduction of the nitrates by the increased amount of sugar present.

Time of experiments (duration). Sept. 19th—Oct. 8th.
Beginning of germination. Sept. 24th.
Solution applied. Oct. 2nd—Oct. 8th.

Temperature in the glass house :—

Min. 17°C. ; Max. 44°C.

Average height of control plants. 8.5$^{c.m.}$
,, ,, ,, the plant in ammonium nitrate. 10.11$^{c.m.}$
,, ,, ,, the plant in sodium nitrate. 9.53$^{c.m.}$
Average fresh weight of a control plant. 1.07 gram.
,, ,, ,, ,, the plant in ammonium nitrate. 1.13 gram.
,, ,, ,, ,, the plant in sodium nitrate. 1.18 gram.
Ammonium nitrate solution applied. 508$^{c.c.}$ = 0.178 gram.
Sodium ,, ,, ,, 608$^{c.c.}$ = 0.201 gram.

Table V :—In 100 parts of dry matter (free from ash).

		Plants treated with ;	
	Control plants	Ammonium nitrate	Sodium nitrate
Albuminoid nitrogen	2.82	2.99	3.11
Proteids	17.64	18.66	19.44
Asparagine nitrogen	1.65	2.57	2.33
Asparagine	7.77	12.10	10.98

V. Experiments with potato plants (Solanum tuberosum).

Well developed potato plants were taken from the field, and placed in the following solutions :—

a, 0.1% solution of ammonium nitrate.
b, 0.2% solution of sodium nitrate.
c, distilled water.

The plants were kept in a glass house.
Time of experiments. Oct. 12th—Oct. 21th.
Temperature :— Min. 16°C. ; Max. 40°C.

At the end of the experiment, the plants began to suffer, and a portion of the roots commenced to decay. Of course, all the unhealthy parts were removed ; only the lower portion of the stem 10–15$^{c.m.}$ in length served for analysis. No ammonia was found either in the original plants or in the other three cases, but

(2) In the second experiments with squash, the plants were also attacked by a fungus; hence I could not continue the experiment.

a moderate quantity of nitrates was found in all cases. A few drops of the juice of the plants in ammonium nitrate were left to dry up on an object carrier, and yielded besides some long needles (probably potassium nitrate), numerous asparagine crystals readily recognized under the microscope by their insolubility in cold saturated asparagine solution.

The result of the analysis was as follows :—

Table VI. In 100 parts of dry matter.

	Original plants (Oct. 12)		Control plants (Oct. 21)	Plants in	
				Ammonium nitrate	Sodium nitrate
	(stem)	(roots)	(stem)	(stem)	(stem)
Asparagine nitrogen	0.20	0.22	0.75	1.51	0.98
Asparagine	0.92	1.02	3.54	7.06	4.61

We observe here that ammonium nitrate was much more favourable for asparagine production than sodium nitrate, and that the control plants kept in water contained much more asparagine than the original plants taken from the field, which fact may be due to the transformation of nitrates, already present in the plants, into asparagine.

Another experiment with potato plants was made on an open farm. The plants 30–40$^{c.m.}$ high were irrigated with :—

a, 0.1% solution of ammonium phosphate.
b, 0.2% ,, ,, sodium nitrate.

There was no rain-fall during the experiment, but sometimes the temperature dropped down to 3°C. at night. After 6 days (Nov. 7th—Nov. 13th), the plants were removed and the entire plants were used for analysis.

Total ammonium phosphate solution applied. 300$^{c.c.}$
,, sodium nitrate ,, ,, 300$^{c.c.}$

Table VII. In 100 parts of dry matter.

	Original plants	Plants treated with	
		Ammonium phosphate	Sodium nitrate
Asparagine nitrogen	0.57	0.37	0.53
Asparagine	2.68	1.76	2.53

In this case we observe no increase of asparagine after the treatment with sodium nitrate, and even a decrease by the treatment with ammonium phosphate. The conditions for the formation of *proteids* from asparagine were evidently very favourable and especially promoted by ammonium phosphate.

VI. Experiments with potato shoots.

A. On April 2nd, etiolated potato shoots which had grown in moist saw dust in the dark, were placed in the following solutions :—

a, 0.2% urea solution.
b, 0.2% sodium nitrate solution.
c, 0.2% urea and 2% sugar solution.
d, 0.2% sodium nitrate and 2% sugar solution.
e, distilled water.

The plants were kept in a dark room for 6 days (April 2nd to April 8th).

The shoots were 12-20$^{cm.}$ long, and weighed 2 grams on an average in the fresh state.

Although they had not grown for 6 days they were still quite healthy ; the solutions had remained almost entirely clear.

Table VIII :—In 100 parts of dry matter :—

	Original plants.	Control plants.	Plants in Urea	Sodium nitrate.	Urea and sugar.	Sodium nitrate and sugar.
Albuminoid nitrogen	2.18	1.90	1.91	1.79	2.11	1.80
Asparagine nitrogen	0.68	0.98	1.65	0.97	1.38	1.18
Asparagine	3 21	4.62	7.78	4.58	6.51	5.56

B. On the 8th of April, the same experiment was repeated but this time, in full day light.

Length of shoots, 12-24$^{cm.}$
Average fresh weight, 1.84$^{gram.}$
Time of experiments, April 8th—April 15th.(1)

Table IX.:—In 100 parts of dry matter :—

	Original plants.	Control plants.	Plants in Sugar.	Urea.	Sodium nitrate.	Sodium nitrate and sugar.
Total nitrogen	3.14	3.29	2.74	3.71	3.48	3.04
Albuminoid nitrogen	1.80	1.86	1.45	1.97	1.89	1.80
Asparagine nitrogen	0.55	0.70	0.75	1.70	0.78	0.56
Nitrogen in nitrates	0	0	0	0	0.21	0.16

As the application of sugar causes a remarkable increase of dry matter in the plants, the percentage of nitrogen is lowered considerably. Therefore, for the sake of correct comparison, I calculated the following table :—

(1) The lower parts of a few shoots were removed, having suffered somewhat.

Table X :—In 100 parts of total nitrogen :—

	Original plants.	Control plants.	Plants in Sugar(1)	Urea(1)	Sodium nitrate.	Sodium nitrate and sugar.
Total nitrogen	100	100	100	100	100	100
Albuminoid nitrogen	57.3	56.5	53.	53.1	54.6	59.2
Asparagine nitrogen	17.5	21.3	27.4	45.8	22.4	18 4
Nitrogen in nitrates	0	0	0	0	6.0	5.2

We observe here no considerable decrease of albuminoid nitrogen during the experiments, but a little increase of asparagine nitrogen takes place in the control and sugar case ; but as this increase does not correspond with the decrease of albuminoid nitrogen, it must be due to the transformation of other amido-compounds into asparagine. We observe here also a very great difference of asparagine nitrogen in the urea and sodium nitrate plants. Sodium nitrate does not here seem well suited to become asparagine. Sugar had no great influence upon the increase of albuminoid nitrogen ; this must be due to the want of some other necessary conditions for the protein formation (want of sulphates ?).

Isolation of asparagine crystals : 3.27^{grams} air dry plants treated with urea yielded 0.1^{gram} by crystallization, while the calculation requires about 0.27^{gram}. In this case, I could not separate the slimy mother liquor which prevented the crystallization of all the asparagine.

VII. Experiments with "*keyasagara*" (*Holesia hispidum*).

Young branches covered with leaves, 25-30$^{cm.}$ in length, were placed in the following solutions :—

a, 0.1% solution of urea.
b, ,, ,, ,, ,, and 10% cane sugar.
c, 0.1% solution of ammonium phosphate,
d, ,, ,, ,, ,, ,, and 10% cane sugar.
e, distilled water.

The objects were kept in the dark, for 7 days (Oct. 31st—Nov. 7th). No ammonia was found stored up after the treatment and the leaves remained generally very healthy.

After drying, the leaves only were subjected to analysis :—

(1) As the total nitrogen in some of the above cases was increased absolutely, the albuminoid nitrogen was *apparently* decreased.

Table XI :—In 100 parts of dry matter :—

	Original plants.	Control plants.	Plants in Amm. phosph.	Amm. phosphate and sugar.	Urea.	Urea and sugar.
Asparagine nitrogen	0.11	0.15	0.16	0.10	0.23	0.12
Asparagine	0.51	0.72	0.73	0.48	1.10	0.55

In this case it is very evident that the introduction of sugar prevented the increase of asparagine.(1)

VIII. Experiments with buckwheat plants (*Polygonum fagopyrum*).

Experiments were made with buckwheat plants taken from the farm in full blossom and *bearing seeds*. There was only a trace of asparagine and a moderate amount of nitrate present, but no trace of ammonia. Preliminary experiments showed further that in this case, some of the ammonia offered as ammonium nitrate in 0.05% solution, was found afterwards as such in the stems to the extent of 0.17%(2) of the air dry matter.

The plants were now placed in the following solutions :—

a, 0.1% solution of ammonium nitrate.

b, 0.1% solution of ammonium chloride.

c, 0.2% solution of sodium nitrate.

d, distilled water.

The plants were kept in the glass house for 9 days (Oct. 12th—21st.).

Temperature :—Min. 16°c ; Max. 40°c.

All the plants were healthy and the solutions remained clear.

The analysis for which only stems and leaves were used yielded the following results :—

Table XII. In 100 parts of the fresh plants :—

	Plants treated with Control plants.	Ammonium chloride.	Ammonium nitrate.	Sodium. nitrate.
Asparagine nitrogen and nitrogen in ammonia.	0.05	0.13	0.08	0.06
Nitrogen in ammonia.	0	0.08	0.04	0
Asparagine nitrogen.	0.05	0 05	0.04	0 06
Asparagine	0.25	0 22	0.18	0.29

(1) A small amount of sulphates was found in the leaves which might have been utilized in the production of new proteids from asparagine and sugar.

(2) Cf. Analytical data in the appendix.

The reason why so little asparagine was formed here and the ammonia taken up remained as such partly preserved in the plant, may be due to the fact that the development of young seeds required most of the sugar produced by the leaves, for the production of starch, and therefore the necessary amount of sugar for the production of asparagine was not available. In the following experiments, therefore, all the flowers and *seeds* were *removed* before the treatment commenced ; the plants were placed in the following solutions ;—

a, 0.1% solution of ammonium nitrate.
b, ,, ,, ,, ,, and 10% sugrr.
c, ,, ,, ,, chloride and 10% sugar.
d, ,, ,, ,, carbonate.
e, ,, ,, ,, ,, and 10% sugar.
f, ,, ,, ,, phosphate.
g, ,, ,, ,, ,, and 10% sugar.

These were kept in the glass house for 11 days (Oct. 24th—Nov. 4th).

Temperature:—Min. 10.5°c.; Max. 37°c.

In this case, the result differed considerably, no trace of ammonia being found in any of them.

The analysis for which only the stems and roots were used, yielded the following results.

Table XIII:—

	Plants treated with						
	Ammonium nitrate.	Ammonium nitrate and sugar.	Ammonium carbonate.	Amm. carbonate and sugar.	Ammonium phosphate.	Amm. phosphate and sugar.	Amm. chloride and sugar.
Asparagine nitrogen.	0.39	0.10	0.48	0.27	0.26	1.10	0.10
Asparagine.	1.82	0.48	2.25	1.27	1.20	0.46	0.50

We see from these results, that the formation of asparagine from ammonia was considerable. The sugar produced from the leaves evidently yielded the carbon for the asparagine but we see also on the other hand, that, in those cases where sugar was added to the solutions, the amount of asparagine was again less, which finds a natural explanation in the fact that, by a larger excess of sugar, the protein production was so stimulated that

the asparagine was again for the greater part consumed.[1] Sugar in the nourishing solution therefore not only prevents asparagine production from proteids, as *Monteverde* has ascertained with *Syringa* but also lowers the amount of asparagine produced from ammonium salts offered to the roots !

IX. (*A.*) Experiments with "*Mikawashima-na*" (*Brassica campestris*).

This experiment was made on the field, the plants about 30$^{cm.}$ high with as yet very small roots were irrigated with the following solutions :—

a, 0.1% solution of ammonium phosphate.
b, 0.2% ,, ,, sodium nitrate.

Duration of experiments, 8 days (Nov. 20th—Nov. 28th).
Total solutions applied for each case, 600 c.c.
The entire plants were used for analysis.

Table XIV. In 100 parts of dry matter :—

		Plants in	
	Control plants.	Ammonium phosphate.	Sodium nitrate.
Asparagine nitrogen	0.85	0.55	0.83
Asparagine	3.99	2.60	3.90

(*B.*) Experimets with *Brassica Campestris*, var, "*Swedish turnip.*"

Full grown plants with large round roots, were removed from the farm, and placed in the following solutions :—

a, 0.1% solution of ammonium nitrate.
b, 0.02% ,, ,, ammonium carbonate.
c, 0.2% ,, ,, sodium nitrate.
d, distilled water.

The plants were kept in the glass house.

Time of experiments :—7 days (Oct. 16th—Oct. 23rd).
Temperature :—Min. 17°c ; Max. 40°c.

At the end of the experiments, the plants had suffered very much, the temperature being too high, and a portion of the roots died. After washing the roots and removing the dried leaves, only the healthy parts were analyzed which yielded the following results :—

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(1) The presence of sulphates, which I found in the leaves and stems, no doubt, rendered this process possible.

Table XV. In 100 parts of dry matter :—

	Original plants.	Control plants.	Plants treated with Ammonium nitrate.	Ammonium carbonate.	Sodium nitrate.
Asparagine nitrogen	0.65	1.51	1.69	1.69	2.04
Asparagine	3.07	7.11	7.99	7.97	9.62

Here, in the control plants, very much asparagine was formed, this can only be due to the transformation of nitrates, originally stored up in the plants, aided by the presence of much sugar. Indeed in a second experiment the decrease of nitrates stored up was plainly observed during this asparagine production ; and in this case even less asparagine was noticed in the plants nourished with ammonium salts. In these experiments, five plants of similar size,[1] were placed in the following solutions :—

a, 0.1% solution of ammonium chloride (1.5 litre).
b, ,, ,, ,, ammonium phosphate (1.5 litre).
c, 0.2% ,, ,, sodium nitrate (,,).
d, distilled water. (,,).

They were kept in the glass house.

Time of experiments :—7 days (Nov. 6-13).

Temperature :—Min. 7°c.; Max. 36°c.

After drying[2] only the healthy stems and leaves were analyzed, with the following results.

Table XVI. In 100 parts of dry matter:

	Original plants.	Control plants.	Plants treated with Ammonium chloride.	Ammonium phosphate.	Sodium nitrate.
Asparagine nitrogen	0.55	1.47	1.25	1.15	1.11
Asparagine	2.57	6.92	5.90	5.40	5 21
Nitrogen in nitrates.	0.83	0.41	—	—	—

(*c*). Experiments with *Brassica campestris*, var. "*Taina*."[3]

Three experiments were made with this variety.

I. Experiment (made on the field).

The young plants growing on the farm about 20cm. high were irrigated with the following solutions :—

(1) The roots weighed 200 grams on an average; the leaves were 30-50 cm. long.

(2) At the end of the experiments the plants in sodium nitrate and ammonium phosphate began to suffer. The other plants were quite healthy.

(3) This variety has very soft juicy leaves and very small roots.

a, 0.2 % solution of ammonium phosphate.
b, 0.4 % ,, ,, sodium nitrate.

Time of experiments, Nov. 23rd-28th.

Total solution applied :

Ammonium phosphate	200 cc.
Sodium nitrate	200 cc.

After drying, the entire plants were analyzed.

Table XVII. In 100 parts of dry matter :—

	Control plants	Plants treated with Ammonium phosphate	Plants treated with Sodium nitrate
Asparagine nitrogen	0.39	0.47	0.42
Asparagine	1.85	2.21	2.00

II. Experiment.

The plants were carefully removed from the field and placed in glass cylinders, each containing 500$^{c.c.}$ of the following solutions, and kept in the glass house :

a, 0.2% solution of ammonium chloride.
b, ,, ,, ,, sodium nitrate.
c, distilled water.

Duration of experiment : 7 days (Nov. 30th—Dec. 7th).

Temperature :— Min. 3°C. ; Max. 33°C.

Total nitrogen absorbed by ;—

a, the plants in ammonium chloride was 0.0462 grams= 0.5% of dry matter.(1)

b, the plants in sodium nitrate was 0.0437 grams=0.59% of dry matter.(2)

The plants remained normal and the solutions quite clear. The analysis, for which the entire plants were used, yielded the following results :—

Table XVIII. In 100 parts of dry matter :—

	Original plants	Control plants	Plants treated with Ammonium chloride	Plants treated with Sodium nitrate
Total nitrogen	4.60	4 44	4.83	4.78
Albuminoid nitrogen	1.65	1.63	1.86	1.35
Asparagine nitrogen(3)	0.28	0.71	0.86	0.95
Nitrogen in nitrates	1.04	0.36	0.62	0.88

(1) Total dry matter of the plants in ammonium chloride (at the end of the experiments) was 9.328 grams.

(2) Total dry matter of the plants in sodium nitrate (at the end of the experiments) was 7.47 grams.

(3) As I had suspected the presence of some organic bases like arginine, etc , I employed first phospho-tungstic acid to remove them. Indeed, the result for asparagine was then considerably lower than by the usual method, while in most of the other cases, I found no essential difference by the previous application of phospho-tungstic acid.

Here also it is seen that the increase of asparagine nitrogen is accompanied with the decrease of nitrates in the plants, and that in this case the asparagine is not a decomposition product of proteids.

The relation of these numbers will become still clearer, if we add the following table :—

Table XIX. In 100 parts of total nitrogen.

	Original plants	Control plants	Plants treated with: Ammonium chloride	Plants treated with: Sodium nitrate
Total nitrogen	100	100	100(1)	100(1)
Albuminoid nitrogen	35.9	36.7	42.9	32 2
Asparagine nitrogen	6 9	16.0	20.0	22.5
Nitrogen in nitrates	22.7	8.1	14.3	21.0

III. Experiment.

Here, the influence of sugar and that of temperature upon the result was to be observed. The plants were taken from the same farm as before, and placed in glass cylinders, containing each 500$^{c.c.}$ of the following solutions :—

a. 10% solution of sugar.
b. 0.2% ,, ,, ammonium chloride.
c. ,, ,, ,, ,, ,, and 10% sugar.
d. ,, ,, ,, sodium nitrate.
e. ,, ,, ,, ,, ,, and 10% sugar.
f. distilled water.

g. 10% sugar solution.
h. distilled water.

a, b, c, d, e, f, were kept in the glass house, while g, and h, were kept in the laboratory, where the temperature was much lower than in the glass house.(2)

Duration of experiment, 8 days (Dec. 10th—18th).
Temperature in the glass house :—Min. 1°C ; Max. 38°C.
,, ,, ,, laboratory :—Min. 5°C ; Max. 15°C.

Plants treated with	Ammonium chloride	Ammonium chloride and sugar	Sodium nitrate	Sodium nitrate and sugar
Total nitrogen absorbed in grams	0.042	0.038	0.041	0.037
Percentage of absorbed nitrogen in the dry matter(3)	0.53%	0.31%	0.54%	0.34%

(1) The nitrogen absorbed during experiments was subtracted from the total nitrogen and the remaining number (= total N. before experiment) was calculated as 100.

(2) Toward the end of the experiment, the plants kept in the sugar solution in the glass house began to suffer. The top of the leaves, dried and turned yellow, but those kept in the cooler laboratory remained healthy.

(3) Total dry matter of the plants treated with ammonium chloride = 7.901 grams.
,, ,, ,, ,, sodium nitrate = 7.619 ,,
,, ,, ,, ammonium chloride and sugar = 12.393 ,,
,, ,, ,, sodium nitrate and sugar = 10.936 ,,

After careful washing and drying the entire, plants were analyzed.

Table XX. In 100 parts of dry matter :—

	Temp. 1–38°C.							Temp. 5–15°C.	
			Plants treated with.						
	Original plants	Control plants.	Sugar	Ammonium chloride	Amm. chloride and sugar	Sodium nitrate	Sodium nitrate and sugar	Control plants	Plants in sugar
Total nitrogen	4.28	3.64	2.48	4.07	2.94	5.00	2.81	4.31	2.63
Albuminoid nitrogen.....	1.98	1.42	1.37	1.76	1.52	1.75	1.31	2.13	1.64
Asparagine nitrogen(1) ...	0.40	0.72	0.18	0.99	0.27	0.82	0.21	0.48	0.22
Nitrogen in nitrates	0.49	0.09	0	0.23	0	0.76	0.14	0.16	0

As the dry matter had increased very much in those plants which were treated with sugar, the percentage of the nitrogen compounds is very much lowered. I calculated therefore the following table to show the relation more clearly :—

Table XXI. In 100 parts of total nitrogen :—

	Temp. 1–38°C.							Temp. 5–15°C.	
			Plants treated with ;—						
	Original plants	Control plants	Sugar	Ammonium chloride	Amm. chloride and sugar	Sodium nitrate	Sodium nitrate and sugar	Control plants	Plants in sugar
Total nitrogen	100	100	100	100(2)	100(2)	100(2)	100(2)	100	100
Albuminoid nitrogen.....	46.3	38.1	55.0	49.7	57.8	39.2	53.0	49.4	62.4
Asparagine nitrogen	9.3	19.8	7.3	28.0	10.3	18.4	8.2	11.1	8.4
Nitrogen in nitrates	11.5	2.5	0	6.5	0	17.0	5.7	3.7	0

(1) Asparagine nitrogen was here determined without previous removal of the bases by phospho-tungstic acid; therefore the result is somewhat too high.

(2) For the calculation the absorbed nitrogen was subtracted from the total nitrogen; otherwise a true comparison is impossible.

It is seen from the above tables that the decrease of asparagine and the transformation of nitrates are enhanced when sugar is offered, and that on the other hand, an increase of albuminoid nitrogen takes place, as was to be expected.[1]

X. Experiments with wheat (*Triticum sativum*).

Young plants 6–10$^{c.m}$ high, were irrigated on the field with the following solutions :—

a. 0.1% solution of ammonium phosphate.
b. 0.2% ,, ,, sodium nitrate.

Time of experiments :—24 days (Nov. 7th—Dec. 1st).

The temperature was sometimes very cold and fell to 3°C. Total solutions added = about 1000$^{c.c.}$ in both cases. (two times irrigated). Rainfall occurred three times during the experiments.

Table XXII. In 100 parts of dry matter.

		Plants treated with	
	Control plants	Ammonium phosphate	Sodium nitrate
Asparagine nitrogen	0.32	0.42	0.47
Asparagine	1.51	1.97	2.21

Here no noticeable quantity of asparagine accumulated, very probably because all the conditions for a rapid formation of proteids were favourable.

Second experiments with wheat.

Young plants 15–20$^{c.m.}$ high, grown on the same farm, were carefully removed, washed, and cultured in the glass house in glass cylinders, containing :—

a. 500$^{c.c.}$ of 0.1% solution of urea.
b. ,, ,, ,, ,, ,, ammonium chloride.
c. ,, ,, 0.05% ,, ,, ammonium carbonate.
d. ,, ,, 0.2% ,, ,, sodium nitrate.
e. distilled water.

Duration of experiment :—11 days (Feb. 3rd–14th).

Temperature :—Min. 2°C. ; Max. 35°C.

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(1) Note on the assimilation of nitrates :—According to *Treub* the first product of assimilation of nitrates in the leaves of *Pangium edule*, (a tree of Java), is prussic acid. (Cf. Chem. Zeitg. Feb. 1896). In my numerous experiments, however, on the assimilation of nitrates, the transformation of nitrates to ammonia, asparagine, or proteids, so quickly proceeded that it was impossible to discover any intermediate product between nitric acid and ammonia.

The solutions were once renewed. The plants were very healthy, and rapid growth was observed : especially was this the case with the ammonium chloride plants. The analysis, for which the entire plants were used, yielded the following results for 100 parts of dry matter :—

Table XXIII.

	Original plants	Control plants	Plants treated with: Ammonium chloride	Ammonium carbonate	Urea	Sodium nitrate
Total nitrogen	3.72	3.73	4.48	4.51	4.63	4.60
Albuminoid nitrogen	1.98	1.81	1.64	1.73	1.96	1.99
Asparagine nitrogen	0.19	0.99	1.48	1.33	1.55	1.13
Nitrate nitrogen	0	0	0	0	0	0.21

Here, a considerable increase of asparagine nitrogen in the control case was observed. This increase may be chiefly due to the transformation of other amido-compounds into asparagine, as there was no nitrate stored up in the plants, and no decomposition of proteids was observed.(1)

Isolation of asparagine crystals from the plants treated with ammonium chloride :—10 grams of the finely powdered substance were repeatedly extracted with warm water, and the extract, after the addition of some tannin and basic lead acetate, was filtered. To the clear filtrate was added an excess of mercuric nitrate solution, whereby a white flocculent precipitate was formed, which, after washing, was decomposed with hydrogen sulphide ; the filtrate from the mercuric sulphide was concentrated on the water bath, the solution being kept always neutral by the addition

(1) The hot aqueous extract of the wheat prepared with boiling water, gave with phospho-tungstic acid a turbidity, and upon further addition of nitric acid, a flocculent precipitate probably due to peptone-like bodies was produced ; but when this extract was first mixed with basic lead acetate until no more precipitate was obtained, the phospho-tungstic acid produced in presence of considerable nitric acid, a smaller amount of pulverulent precipitate, probably due to traces of a base like choline or betain. This filtrate of the lead precipitate did not give any reaction whatever with caustic potash upon the addition of a trace of copper sulphate (biuret reaction); therefore no peptone was present.

Neither ammonia nor urea was stored up as such in the treated plants. A finely powdered dry sample was extracted with hot absolute alcohol, the alcohol was distilled off, and the residue after removal of impurities by basic lead acetate, was precipitated with mercuric nitrate solution, the solution being kept almost neutral, the precipitate was decomposed by hydrogen sulphide, the filtrate evaporated (keeping it always neutral by the addition of baryta solution) and the evaporated residue again extracted with warm absolute alcohol and evaporated again ; hereby *no crystals of Urea*, were observed nor any crystallization upon the addition of nitric acid or oxalic acid.

of dilute dammonia. The concentrated solution yielded an abundant quantity of large asparagine crystals which were washed with water and then with absolute alcohol, and dried over sulphuric acid. The amount thus obtained was 0.51 gram,[1] the analysis proved the crystals to be pure asparagine.

	Calculated	Observed
Nitrogen	18.66 %	18.45 %
Water of crystallization... (lost at 100°C.)	12.0 %	12.2 %

XI. Experiment with barley (*Hordeum distichon*).

Young barley plants of an average hight of 32$^{cm.}$ were removed from field and placed (in the glass house) in the following solutions :—

a. 0.2 % urea.
b. ,, ,, and 2 % sugar.
c. ,, ammonium chloride.
d. ,, ,, ,, and 2 % sugar.
e. 2 % sugar.
f. distilled water.

Duration of experiment :—7 days (March 26th—April 2nd).
Temperature :—Min. 10°C. ; Max 45°C.

After drying, the entire plants[2] were analyzed with the following result :—

Table XXIV. In 100 parts of dry matter :—

	Original plants	Control plants	Plants treated with: Sugar	Urea	Urea and sugar	Amm. chloride	Amm. chloride and sugar
Total nitrogen	5.13	5.08	4.60	5 65	4.98	5.73	5.00
Alb. nitrogen	2.16	1.86	1.47	1.50	1.28	1.60	1 23
Asp. nitrogen	0.93	1.84	1.94	1.87(?)	2.15	3.21	2.09
Nitrate nitrogen	0.58	0.37	0.35	0.49	0.24	0.28	0.23

Table XXV. In 100 parts of total nitrogen :—

	Original plants	Control plants	Plants treated with: Sugar	Urea	Urea and sugar	Amm. chloride	Amm. chloride and sugar
Total nitrogen	100	100	100	100	100	100	100
Alb. nitrogen	42.3	36.6	32	26.6	25.7	27.9	24.6
Asp. nitrogen	18.1	36.2	42.2	33.1(?)	43.2	55.8	41.8
Nitrate nitrogen	11.4	7.3	7.6	8.6	4.8	4.9	4.6

(1) A moderate quantity of asparagine was left in the mother liquor, which was not considered.

(2) Toward the end of the experiments some leaves or tips of leaves began to dry up, owing to the high temperature. Such leaves were, of course, removed.

In this table we see that the ratio of albuminoid nitrogen, etc. is very low, but this does not indicate the decrease of these nitrogen compounds. The albuminoid nitrogen is only relatively lowered, the total nitrogen being considerably increased.

I sought to prove further that asparagine accumulates, even in presence of much sugar, when some of the other necessary agents for protein formation are wanting. For this purpose, the young barley plants of about 32$^{cm.}$ high, were first *cultured in the 2 % sugar solution.* After 7 days, a portion was directly dried and analyzed, while another portion, was divided into three equal parts, and cultured in the following solutions :—

a. 0.2 % solution of urea.
b. ,, ,, ,, sodium nitrate and 2 % sugar.
c. ,, ,, ,, urea and 2 % sugar.

The plants exposed to ordinary daylight, were after 7 days (March 26th, April 2nd) washed, dried, and analyzed :—
Table XXVI. In 100 parts of dry matter :—

	Original[1] plants.	Urea.	Sodium nitrate and sugar.	Urea and sugar.
Total nitrogen	4.60	6.09	5.64	5.98
Albuminoid nitrogen	1.47	1.52	1.52	1.58
Asparagine nitrogen	1.94	2.97	2.44	3.15
Nitrate nitrogen	0.35	0.24	0.53	0.25

In this case, it is seen that by offering sugar together with urea, the asparagine nitrogen was increased considerably. By the preliminary culture for a week in the sugar solution, some of the conditions for protein formation had been removed, and, I suppose, it was the sulphates, that were used up. Thus, all the ammonium compounds had to be stored up as asparagine and could not be transformed any farther.

SUMMARY AND CONCLUSION.

(1). Asparagine in plants has two sources :—

(*a*). It is derived from the decomposition of proteids.

(*b*). It is a synthetical product of other nitrogenous compounds :—

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(1) The quantitative determination of asparagine by the crystallization method was not very satisfactory, as some slimy substance prevented a considerable portion from crystallizing.

1. Ammonium salts, (and also urea).
2. Nitrates.

(2). Asparagine is formed not only by keeping full-grown plants in the dark, but also can be formed in full daylight under certain conditions.

(3). Synthetic formation of asparagine is only possible, when sugar is present in the plant, and at the same time some condition for protein formation is wanting. Excess of sugar prevents the asparagine formation from proteids, but it does not prevent the synthetical formation of asparagine ; it even stimulates its formation.

(4). Ammonia is never stored up as such in plants ; it disappears quickly forming innocuous compounds ; but when the necessary amount of sugar is wanting, the ammonia can not be converted and remains as such (experiments with buckwheat) to a small extent in the plant ; a larger amount is noxious.[1]

(5). *Ammonium salts are generally better than sodium nitrate for asparagine production.*

(6). Among the several ammonium salts, ammonium chloride is the best, while the ammonium phosphate is always less favourable for the formation of asparagine ; very probably the formation of nuclein and new cells are stimulated very much by phosphates ; the asparagine once formed is thus easily transformed into proteids.

Urea is generally better than ammonium salts for asparagine production (except with barley experiments).

(7). For the conversion of nitrates, a high temperature and the presence of sugar are necessary, otherwise they remain as such stored up in the plants for some time.

(8). The conversion of asparagine into proteids is only possible when all conditions are fulfilled. One of the most essential conditions is of course the presence of sulphates.

(9). In etiolated shoots sodium nitrate can not be converted into asparagine but urea is capable of yielding it.

(10). In etiolated shoots the application of sugar increases the amount of asparagine, when sodium nitrate or ammonium salts are offered.

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(1) Mr. *Aoyama* in our laboratory made some experiments which show very clearly the poisonous action of ammonium salts, when the necessary amount of sugar is not present to transform them into asparagine.

ANALYTICAL DATA.

For the determination of total nitrogen cited in the foregoing pages 0.5 or 1.0^{gram} of air dry sample was mixed with 30$^{c.c.}$ sulphuric acid, 1^{gram} sugar, 2^{grams} benzoic acid, 1^{gram} mercury and 0.5^{gram} copper sulphate, and decomposed and distilled as usual.

For the determination of proteid nitrogen, *Stutzer's* method was used.

For the determination of asparagine nitrogen *Sacchsse's* method was generally used, but in some cases, when the presence of organic bases was suspected, phospho-tungstic acid was previously applied.

For the determination of nitrates, *Tiemann* and *Schultze's* method was used.

HELIANTHUS ANNUUS.

ASPARAGINE NITROGEN.

Plants in	Dry matter used in grams.	Baryta(1) water replaced in c.c.	Nitrogen found in gram.	Percentage of nitrogen (= ½ asp. nitrogen.)
Ammonium nitrate	1. 4.535	18.8	0.0178	0.39
	2. „	18.6	0.0176	
Ammonium chloride	1. 4.485	23.7	0.0224	0.50
	2. „	23.4	0.0221	
Sodium nitrate	1. 4.550	9.4	0.0089	0.20
	2. „	9.4	0.0066	
Control plants	1. 4.515	7.0	0.0064	0.15
	2. „	6.8	0.0030	
Original plants	1. 4.405	3.2	0.0029	0.07
	2. „	3.1	0.0029	

(1) 10 *c.c.* of the standard sulphuric acid were equivalent to 48 *c.c.* baryta solution, and yielded 0.374 gram barium sulphate. Hence 1*c.c.* of the baryta solution = 0.0009447 gram nitrogen.

YELLOW LUPINE.

ASPARAGINE NITROGEN.

Plants in	Dry matter used in grams.	Baryta water[1] replaced in c.c.	Nitrogen found in grams.	Percentage of nitrogen ($\frac{1}{2}$ asparagine nitrogen).
Ammonium phosphate.....	1. 1.148	3.8	0.0036	0.31
	2. „	3.7	0.0035	
Urea	1. 1.829	11.6	0.0110	0.59
	2. „	11.4	0.0108	
Sodium nitrate	1. 1.381	5.2	0.0048	0.36
	2. „	5.2	0.0048	
Control plants	1. 0.919	2.0	0.0019	0.20
	2. „	1.9	0.0018	
Original plants	1. 1.873	3.8	0.0036	0.19
	2. „	3.6	0.0034	

MELIA JAPONICA.

ASPARAGINE NITROGEN.

Plants in	Dry matter used in grams.	Baryta water[2] replaced in c.c.	Nitrogen found in grams.	Percentage of nitrogen ($\frac{1}{2}$ asparagine nitrogen.
Ammonium phosphate	1. 4.568	3.0	0.0067	0.15
	2. „	3.2		
Ammonium chloride	1. 4.368	4.0	0.0082	0.19
	2. „	3.7		
Sodium nitrates.....	1. 4.373	2.7	0.0058	0.13
	2. „	2.7		
Control plants	1. 4.420	1.2	0.0028	0.06
	2. „	1.3		
Original plants	1. 4.673	1.1	0.0026	0.06
	2. „	1.3		

(1) 1 *c.c.* of the baryta solution = 0.0009447 gram nitrogen.

(2) 10 *c.c.* of the standard sulphuric acid were equivalent to 64 *c.c.* baryta solution and yielded 0.572 gram barium sulphate. Hence 1 *c.c.* baryta solution = 0.002148 gram nitrogen.

SQUASH (I.)

ALBUMINOID NITROGEN.

Plants in	Dry matter used (free from ash) in gram.	Baryta water[1] replaced in c.c.	Nitrogen found in grams.	Percentage of nitrogen.
Ammonium nitrate ...	1. 0.711	16.7	0.0181	2.58
	2. „	16.9		
Sodium nitrate	1. 0.788	19.2	0.0208	2.53
	2. „	19.2		
Control plants	1. 0.694	15.9	0.0173	2.49
	2. „	16.1		

ASPARAGINE NITROGEN.

Plants in	Dry matter used (free from ash) in grams.	Soda water[2] replaced.	Nitrogen found in grams.	Percentage of nitrogen (=½ asparagine nitrogen.)
Ammonium nitrate ...	1. 0.711	3.2	0.0140	1.97
	2. „	3.3		
Sodium nitrate	1. 0.788	2.9	0.0131	1.66
	2. „	3.1		
Control plants	1. 0.694	1.1	0.0048	0.69
	2. „	1.1		

(1) 10*c.c.* of the standard sulphuric acid were equivalent to 66.8 *c.c.* baryta solution and yielded 0.600.603 gram barium sulphate. Hence 1 *c.c.* of the baryta solution = 0.001094 gram nitrogen.

(2) 10 *c.c.* of the standard sulphuric acid were equivalent to 19.75 *c.c.* soda solution, and 1 *c.c.* of the soda solution = 0.004364 gram nitrogen.

SQUASH (II.)

ALBUMINOID NITROGEN.

Plants in	Dry matter (free from ash) used in grams.	Baryta water[1] replaced in c.c.	Nitrogen found in grams.	Percentage of nitrogen.
Ammonium nitrate ...	1. 0.799	25.5	0.0241	2.99
	2. „	25.5		
Sodium nitrate	1. 0.753	24.9	0.0236	3.11
	2. „	25.1		
Control plants	1. 0.411	12.4	0.0118	2.82
	1. „	12.5		

ASPARAGINE NITROGEN.

Plants	Dry matter (free from ash) used in grams.	Baryta water[1] replaced in c.c.	Nitrogen found in gram.	Percentage of nitrogen ($\frac{1}{2}$ asp. nitrogen.
Ammonium nitrate ...	1. 0.799	11.1	0.0105	1.28
	2. „	10.7	0.0101	
Sodium nitrate	1. 0.752	9.4	0.0089	1.17
	2. „	9.1	0.0086	
Control plants	1. 0.411	3.6	0.0034	0.82
	2. „	3.5	0.0033	

(1) 1 *c.c.* of the baryta solution = 0.0009447 gram nitrogen.

POTATO (I.)

ASPARAGINE NITROGEN.

Plants in	Dry matter used in grams.	Baryta water[1] replaced in c.c.	Nitrogen found in grams.	Percentage of nitrogen ($\frac{1}{2}$ asp. nitrogen.
Ammonium nitrate ...	1. 6.955	55.8	0.0527	0.76
	2. „	55.4	0.0523	
Sodium nitrate	1. 5.981	30.8	0.0290	0.49
	2. „	31.2	0.0295	
Control plants	1. 7.049	27.8	0.0263	0.38
	2. „	28.4	0.0267	
Original plant, roots...	1. 2.097	2.5	0.0024	0.11
	2. „	2.3	0.0022	
Original plant, stems...	1. 2.558	2.6	0.0025	0.10
	2. „	2.7	0.0026	

POTATO. (II).

ASPARAGINE NITROGEN.

Plants in	Dry matter used.	Baryta water[2] replaced.	Nitrogen found.	Percentage of nitrogen ($\frac{1}{2}$ asp. nitrogen.)
	Grams.	c. c.	Gram.	
Ammonium phosphate	1. 4.492	8.7	0.0082	0.19
	2. 1.797	3.6	0.0034	
Sodium Nitrate	1. 1.156	3.2	0.0032	0.27
	2. „	3.3	0.0030	
Control plants	1. 2.312	6.9	0.0065	0.28
	2. „	7.0	0.0066	

(1) 1 *c.c.* baryta solution = 0.0009447 gram nitrogen.
(2) 1 *c.c.* baryta solution = 0.0009447 gram nitrogen.

POTATO SHOOTS. (I).

ALBUMINOID NITROGEN.

Plants in	Dry matter used.	Baryta water (1) replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Urea	0.834	5.1	0.0159	1.91
Sodium nitrate	1.288	7.7	0.0231	1.79
Urea and Sugar.....	0.770	5.2	0.0162	2.11
Sod. nitrate and Sugar	0.635	3.7	0.0116	1.80
Control plants	0.641	3.9	0.0122	1.91
Original plants	0.645	4.5	0.0141	2.18

ASPARAGINE NITROGEN.

Plants in	Dry matter used.	Baryta water(1) replaced.	Nitrogen found.	Percentage of nitrogen ($\frac{1}{2}$ asp. nitrogen.)
	Gram.	c. c.	Gram.	
Urea	0.834	2.2	0.0069	0.82
Sodium nitrate	1.288	2.0	0.0062	0.48
Urea and Sugar.....	0.770	1.7	0.0053	0.69
Sod. nitrate and Sugar	0.635	1.2	0.0037	0.59
Control plants	0.641	1.0	0.0031	0.49
Original plants	0.645	0.7	0.0022	0.34

(1) 5 *c.c.* of the standard sulphuric acid were equivalent to 22 *c.c.* baryta solution and yielded 0.5695 gram barium sulphate. Hence 1 *c.c.* baryta solution = 0.0031245 gram nitrogen.

POTATO SHOOTS. (II).

TOTAL NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Sugar	1. 0.456	4.0	0.0125	2.74
	2. „	4.0		
Urea	1. 0.454	5.3	0.0169	3.71
	2. „	5.5		
Sodium nitrate	1. 0.440	4.8	0.0153	3.48
	2. „	5.0		
Sodium nitrate and Sugar	1. 0.472	4 6	0.0144	3.04
	2. „	4.6		
Control plants	1. 0.447	4.7	0.0147	3.29
	2. „	4.8		
Original plants	1. 0.478	4.7	0.0150	3.14
	2. „	4.9		

ALBUMINOID NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Sugar	1. 0.912	4.2	0.0132	1.45
	2. „	4.4		
Urea	1. 0.908	5.7	0.0179	1.97
	2. „	5.7		
Sodium nitrate	1. 0.880	5.2	0.0167	1.89
	2. „	5.4		
Sodium nitrate and Sugar	1. 0.944	5.3	0.0170	1.80
	2. „	5.4		
Control plants	1. 0.894	5.3	0.0170	1.86
	3. „	5.3		
Original plants	1. 0.956	5.4	0.0173	1.81
	2. „	5.6		

(1) 1 *c.c.* baryta solution = 0.0031245 gram nitrogen.

ASPARAGINE NITROGEN.

Plants in	Dry matter used in grams.	Baryta water[1] replaced in cc.	Nitrogen found in grams.	Percentage of nitrogen ($\frac{1}{2}$ asp. nitrogen.)
Sugar	1. 1.824	2.2	0.0069	0.38
	2. „	2.2		
Urea	1. 1.816	5.1	0.0162	0.90
	2. „	5.3		
Sodium nitrate	1. 1.760	2.1	0.0069	0.39
	2. „	2.2		
Sodium nitrate and sugar	1. 1.888	1.6	0.0053	0.28
	2. „	1.8		
Control plants	1. 1.788	2.0	0.0062	0.35
	2. „	2.1		
Original plants	1. 1.912	1.7	0.0053	0.28
	2. „	1.7		

NITRATE NITROGEN.

Plants in	Dry matter in grams.	Height of barometer in inches.	Temperature °C	Volume of NO gas in cc.	Nitrogen found in grams.	Percentage of nitrogen.
Sodium nitrate...	0.880	30.12	17	3.0	0.0018	0.21
Sodium nitrate and sugar	0.944	„	18	2.6	0.0016	0.16

(1) 1 *c.c.* baryta solution = 0.0031245 gram nitrogen.

HOLESIA HISPIDUM.

ASPARAGINE NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen ($\frac{1}{2}$ asp. nitrogen.)
	Gram.	c.c.	Gram.	
Ammonium phosphate	1. 3.664	3.0	0.0028	0.08
	2. „	3.0		
Ammonium phosphate and sugar	1. 3.724	1.9	0.0019	0.05
	2. „	2.1		
Urea	1. 3.668	4.2	0.0042	0.11
	2. „	4.5		
Urea and sugar.....	1. 1.790	1.0	0.0010	0.06
	2. „	1.2		
Control plants	1. 3.692	3.0	0.0028	0.08
	2. „	3.0		
Original plants	1. 2.601	1.5	0.0015	0.06
	2. „	1.6		

BUCKWHEAT. (I.)

DETERMINATION OF AMMONIA.

One gram of air dry matter of the ammonium nitrate plant (lower stems and roots) was extracted with warm water and to the filtrate, to which so much sodium bicarbonate added as necessary to render the liquid slightly alkaline, yielded on distillation 0.0017 gram nitrogen (=1.8cc. baryta solution[1]) =0.17% nitrogen.

Air dry samples were mixed with some caustic lime and moistened with water. The mixture was kept under a bell jar. The ammonia liberated was absorbed by a known quantity of standard sulphuric acid ; thus I obtained the following results:—

1 gram of air dry sample of the control plants yielded 0.0004 gram nitrogen (=0.4cc. baryta solution[1])=0.04% nitrogen.

(1) 1 *c.c.* of the baryta solution = 0.0009447 gram nitrogen.

1 gram of air dry sample of the plants in ammonium nitrate yielded

0.0019 gram nitrogen (=2.0cc. baryta solution[1])=0.19% nitrogen.

1 gram of air dry sample of the plants in sodium nitrate yielded 0.0008 gram nitrogen (=0.8cc. baryta solution[1]) =0.08% nitrogen.[2]

BUCKWHEAT (II.)

ASPARAGINE NITROGEN.

Plants in	Fresh sample used in grams.	Baryta water[1] replaced in cc.	Nitrogen found in grams.	Percentage of nitrogen (=½ asp. nitrogen.)
Ammonium chloride...	5.0	5.4	0.0051	0.10
Ammonium nitrate ...	5.0	3.2	0.0030	0.06
Sodium nitrate	5.0	1.6	0.0015	0.03
Control plants	5.0	1.4	0.0013	0.03

AMMONIACAL NITROGEN.

Plants in	Fresh sample used in grams.	Baryta water[1] replaced in cc.	Nitrogen found in grams.	Percentage of nitrogen.)
Ammonium chloride...	7.45	6.0	0.0057	0.08
Ammonium nitrate ...	6.20	2.7	0.0026	0.04

(1) 1 *c.c.* of the baryta solution = 0.0009447 gram nitrogen.

(2) There are doubtless also traces of asparagine decomposed by calcium hydrate at the ordinary temperature; the small quantities of ammonia obtained from the control plants and the plants in sodium nitrate seem to be due to this source. Control test with Nessler's reagent (added to the cold extracts of the control plants and plants in sodium nitrate) lead me to this inference.

BUCKWHEAT (III.)

ASPARAGINE NITROGEN.

Plants in	Dry matter used in grams.	Baryta water[1] replaced in cc.	Nitrogen found in grams.	Percentage of nitrogen (=½ asp. nitrogen.)
Ammonium chloride and sugar	1.846	0.95	0.0009	0.05
Ammonium nitrate ...	1.910	3.9	0.0037	0.19
Ammonium nitrate and sugar	1.864	1.0	0.0009	0.05
Ammonium carbonate.	1.902	4 8	0.0046	0.24
Ammonium carbonate and sugar	1.826	2.6	0.0025	0.14
Ammonium phosphate.	1.852	2.5	0.0024	0.13
Ammonium phosphate and sugar	1.755	0.9	0.0009	0.05

BRASSICA (*MIKAWASHIMA.*)

ASPARAGINE NITROGEN.

Plants in	Dry matter used in grams.	Baryta water[1] replaced in cc.	Nitrogen found in grams.	Percentage of nitrogen (½ asp. nitrogen.)
Ammonium phosphate	0.866	1.1	0.0024	0.27
Sodium nitrate	0.885	1.7	0.0037	0.41
Control plants	0.864	1.7	0.0037	0.42

(1) 1 *c.c.* baryta solution = 0.0009447 gram nitrogen.

BRASSICA, SWEDISH TURNIP. (I.)

ASPARAGINE NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen ($\frac{1}{2}$ asparagine nitrogen.)
	Gram.	c. c.	Gram.	
Ammonium Nitrate ...	1. 7.710 2. „	68.8 69.4	0.0653	0.85
Ammonium carbonate	1. 7.181 2. „	74.2 74.6	0.0608	0.85
Sodium nitrate	1. 7.257 2. „	78.3 78.5	0.0741	1.02
Control plants	1. 9.814 2. „	78.2 78.6	0.0741	0.75
Original plants	1. 3.774 2. „	12.8 13.0	0.0123	0.32

BRASSICA, SWEDISH TURNIP. (II.)

ASPARAGINE NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen ($\frac{1}{2}$ asparagine nitrogen.)
	Gram.	c. c.	Gram.	
Ammonium chloride	1. 3.591 2. „	23.6 24.0	0.0225	0.63
Ammonium phosphate	1. 2.968 2. „	18.1 17.9	0.0170	0.57
Sodium nitrate	1. 3.673 2. „	21.3 21.7	0.0203	0.55
Control plants	1. 3.669 2. „	28.3 28.7	0.0269	0.73
Original plants	1. 3.651 2. „	10.4 10.6	0.0100	0.27

(1) 1 *c.c.* baryta solution = 0.0099447 gram nitrogen.

NITRATE NITROGEN.

	Dry matter used.	Pressure.	Temperature.	Volume of NO gas.	Nitrogen found.	Percentage of nitrogen.
	Gram.	Inch.	°c.	c. c.	Gram.	
Control plants ...	1. 0.913	30.36	9	11.9	0.0076	0.83
	2. „	„	„	12.1		
Original plants...	1. 0.917	„	„	6.0	0.0038	0.41
	2. „	„	„	6.0		

BRASSICA. (TAINA). (I.)

ASPARAGINE NITROGEN.

Plants in	Dry matter used.	Baryta water(1) replaced.	Nitrogen found.	Percentage of nitrogen ($\frac{1}{2}$ asparagine nitrogen.)
	Gram.	c. c.	Gram.	
Ammonium phosphate	1.840	2.0	0.0043	0.23
Sodium nitrate	1.830	1.8	0.0039	0.21
Control plants	1.858	1.7	0.0037	0.20

BRASSICA. (TAINA). (II.)

I. Nitrogen determination of ammonium chloride solution applied to the plant (before experiments). $5^{c.c.}$ of the ammonium chloride solution were diluted with water to $250^{c.c.}$, and from this $20^{c.c.}$ and $100^{c.c.}$ were distilled after addition of soda solutions.

1. $20^{c.c.}$ yielded 0.0160 gram nitrogen (= $16.9^{c.c.}$ baryta solution(1)) = 0.08% nitrogen.

2. $100^{c.c.}$ yielded 0.0792 gram nitrogen (= $83.8^{c.c.}$ baryta solution) = 0.08% nitrogen.

This calculated to the original solution gives

1. 3.99%
2. 3.96%. Average 3.98%.

(1) 1 *c.c.* baryta solution = 0.0009447 gram nitrogen.

Hence 1$^{c.c.}$ of the ammonium chloride solution contains 0.0398 gram nitrogen.

15$^{c.c.}$ of the ammonium chloride solution contains 0.5963 gram nitrogen.

II. Nitrogen determination of the ammonium chloride solution that had remained unabsorbed, (after experiment). Total unabsorbed solution were filled up to 500$^{c.c.}$, from which 20$^{c.c.}$ and 30$^{c.c.}$ were distilled as above.

1. 20$^{c.c.}$ yielded 0.0220 gram nitrogen (=23.3$^{c.c.}$ baryta solution)=0.1% nitrogen.

2. 30$^{c.c.}$ yielded 0.0330 gram nitrogen (=34.9$^{c.c.}$ baryta solution)=0.1% nitrogen,

which, calculated to the original solution, give

1. 3.67%

2. 3.66%. Average 3.67% nitrogen.

Therefore, total nitrogen remained unabsorbed=0.5501 gram.

Total nitrogen originally applied =0.5963 gram.

Total nitrogen absorbed =0.0462 gram.

III. Nitrogen determination of sodium nitrate solution applied to the plant (before experiment.)

10$^{c.c.}$ of the sodium nitrate solution were diluted up to 100$^{c.c.}$, from which each 10$^{c.c.}$ were taken for analysis.

1. 10$^{c.c.}$ yielded 0.0150 gram nitrogen (temp. 6 °C., pressure 29.84 inches ; NO=24.5$^{c.c.}$).

=1.50% or 15.0% of original solution.

2. 10$^{c.c.}$ yielded 0.0150 gram nitrogen (temp. 6.°C., pressure 29.84 inches ; NO=24.5$^{c.c.}$).

Hence 30$^{c.c.}$ of the sodium nitrate solution contain 0.4497 gram nitrogen.

VI. Determination of unabsorbed nitrogen in the sodium nitrate solution.

Total unabsorbed solution were concentrated to 1000$^{c.c.}$ from which 50$^{c.c.}$ were analyzed.

1. 50$^{c.c.}$ yielded 0.0203 grams nitrogen (temp. 14.5°C., pressure 30.18 inches ; NO=33.8$^{c.c.}$).

2. 50$^{c.c.}$ yielded 0.0203 grams nitrogen (temp. 14.5°C., pressure 30.18 inches ; NO=33.8$^{c.c.}$).

Total nitrogen remained unabsorbed=0.4060 gram.

Total nitrogen originally applied =0.4497 gram.

Therefore, total nitrogen absorbed by plants=0.0437 gram.

TOTAL NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Ammonium chloride...	1. 0.472	10.5	0.0228	4.83
	2. „	10.6		
Sodium nitrate	1. 0.454	10.0	0.0217	4.78
	2. „	10.2		
Control plants	1. 0.455	9.4	0.0202	4.44
	2. „	9.4		
Orginal plants	1. 0.462	9.8	0.0213	4.60
	2. „	10.0		

ALBUMINOID NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram	c. c.	Gram.	
Ammonium chloride...	1. 1.888	16.1	0.0350	1.86
	2. „	16.5		
Sodium nitrate	1. 0.908	5.6	0.0122	1.35
	2. „	5.8		
Control plants	1. 0.910	6.9	0.0148	1.63
	2. „	6.9		
Original plants	1. 0.924	7.0	0.0153	1 65
	2. „	7.2		

(1) 1 *c.c.* baryta solution = 0 002148 gram nitrogen.

ASPARAGINE NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen ($\frac{1}{2}$ asparagine nitrogen.)
	Gram.	c. c.	Gram.	
Ammonium chloride...	1. 1.888	3.8	0.0082	0.43
	2. „	3.8		
Sodium nitrate	1. 1.816	4.1	0.0086	0.47
	2. „	3.9		
Control plants	1. 1.820	3.1	0.0064	0.35
	2. „	2.9		
Original plants	1. 1.848	1.2	0.0026	0.14
	2. „	1.2		

NITRATE NITROGEN.

Plants in	Dry matter used.	Pressure.	Temperature.	Volume of NO. gas.	Nitrogen found.	Percentage of nitrogen.
	Gram	Inch.	°c.	c. c.	Gram.	
Amm. chloride...	1. 0.944	29.7	14.5	10.0	0.0058	0.62
	2. „	„	„	9.8		
Sodium nitrate...	1. 0.908	„	„	13.3	0.0080	0.88
	2. „	„	„	13.7		
Control plants ...	1. 0.910	„	16.	5.4	0.0032	0.36
	2. „	„	„	5.6		
Original plants ..	1. 0.924	„	„	16.3	0.0096	1.04
	2. „	„	„	16.4		

(1) 1 *c.c.* baryta solution = 0.002148 gram nitrogen.

BRASSICA CAMPESTRIS VAR. TAINA. (III.)

I. Examination of ammonium chloride solution that remained unabsorbed. The total solutions were diluted to 500$^{c.c.}$, of which 200$^{c.c.}$ and 100$^{c.c.}$ were analyzed.

(a). 200$^{c.c.}$ of the ammonium chloride solution yielded 0.0627 gram nitrogen (=66.3$^{c.c.}$ baryta solution).

Hence total nitrogen in total solution=0.1568 gram.

(b). 100$^{c.c.}$ of the ammonium chloride and sugar solution yielded 0.0321 gram nitrogen (=34$^{c.c.}$ baryta solution).

Hence total nitrogen in total solution=0.1606 gram.

Total nitrogen originally applied=0.1988 gram.

Therefore, 0.1988−0.1568=0.042 gram nitrogen was absorbed by ammonium chloride plants.

0.1958−0.1606=0.0382 gram nitrogen was absorbed by ammonium chloride and sugar plants.

II. Examination of sodium nitrate solution that remained unabsorbed. The total solutions were concentrated to 100$^{c.c.}$, from which 20 and 10$^{c.c.}$ were analyzed.

(a). 20$^{c.c.}$ of sodium nitrate yielded

0.0218 gram (temp. 15°C., pressure 29.66 inch., vol. of NO 36.4 ;$^{c.c.}$).

Total nitrogen in total solution=0.1090 gram.

(b). 10$^{c.c.}$ of sodium nitrate and sugar solution yielded

0.0113 gram nitrogen (temp. 15°C ; pressure 30 inches ; vol. of NO 18.5$^{c.c.}$).

Total nitrogen in total solution=0.1126 gram.

Total nitrogen originally applied=0.1499 gram nitrogen.

0.1499−0.1090=0.0409 gram nitrogen was absorbed by sodium nitrate plants.

0.1499−0.1126=0.0373 gram nitrogen was absorbed by sodium nitrate and sugar plants.

TOTAL NITROGEN.

Plants in	Dry matter used.	Baryta water(1) replaced.	Nitrogen found	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Sugar	1. 0.477	5.6	0.0118	2.48
	2. „	5.4		
Ammonium chloride...	1. 0.465	8.7	0.0189	4.07
	2. „	8.9		
Ammonium chloride and sugar	1. 0.482	6.5	0.0142	2,94
	2. „	6.6		
Sodium nitrate	1. 0.447	10.4	0.0223	5.00
	2. „	10.4		
Sodium nitrate and sugar	1. 0.459	6.0	0 0129	2.81
	2. „	6.0		
Control plants	1. 0.460	7.9	0.0168	3 64
	2. „	7.7		
Original plants	1. 0.482	9.6	0.0206	4.28
	2. „	9.7		

(1) 1 *c.c.* baryta solution = 0.002148 gram nitrogen.

ALBUMINOID NITROGEN.

Plants in	Dry matter used.	Baryta water(1) replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Sugar	1. 0.954	6.0	0.0131	1.37
	2. „	6.2		
Ammonium chloride...	1. 0.930	7.7	0.0163	1.76
	2. „	7 7		
Ammonium chloride and sugar	1. 0.964	6.8	0.0146	1.52
	2. „	7.0		
Sodium nitrate	1. 0.894	7.3	0.0157	1.75
	2. „	7.4		
Sodium nitrate and sugar	1. 0.919	5 6	0.0120	1.31
	2. „	5.8		
Control plants	1. 0.920	6.1	0 0133	1.43
	2. „	6.3		
Original plants	1. 0.964	9 0	0.0193	1.98
	2. „	9.0		

(1) 1 *c.c.* baryta solution = 0.002148 gram nitrogen.

ASPARAGINE NITROGEN.

Plants in	Dry matter used.	Baryta water(1) replaced.	Nitrogen found.	Percentage of nitrogen ($\frac{1}{2}$ asp. nitrogen).
	Gram.	c. c.	Gram.	
Sugar	1. 1.908	0.7	0.0017	0.09
	2. „	0.9		
Ammanium chloride...	1. 1.860	4.2	0.0092	0.50
	2. „	4.4		
Ammonium chloride and sugar	1. 1.928	1.2	0.0026	0.13
	2. „	1.2		
Sodium nitrate	1. 1.788	3.3	0.0073	0.41
	2. „	3.4		
Sodium nitrate and sugar	1. 1.838	0.8	0.0019	0.11
	2. „	1.0		
Control plants	1. 1.840	3.1	0.0067	0.36
	2. „	3.1		
Original plants	1. 1.928	1.7	0.0039	0.20
	2. „	1.9		

NITRATE NITROGEN.

Plants in	Dry matter used.	Pressure.	Temperature.	Volume of NO gas.	Nitrogen found.	Percentage of nitrogen.
	Gram.	Inch.	°c.	c.c.	Gram.	
Sugar	0.954	29.84	6	0	0	0
Amm. chloride...	0.930	„	7	3.5	0.0021	0.23
Amm. chloride and sugar.....	0.964	„	7	0	0	0
Sodium nitrate...	0.894	29.7	16	11.5	0.0068	0.76
Sodium nitrate and sugar	0.919	30.17	13	2.1	0.0013	0.14
Control plants ...	0.920	29.84	6	1.4	0.0009	0.09
Original plants...	0.964	„	7	7.7	0.0047	0.49

(1) 1 *c.c.* baryta solution = 0.002148 gram nitrogen.

BRASSICA. (TAINA). (IV.)

TOTAL NITROGEN.

	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Plants in sugar	1. 0.491	6.1	0.0129	2.63
	2. „	5.9		
Control plants	1. 0.489	9.8	0.0211	4.31
	2. „	9.9		

ALBUMINOID NITROGEN.

	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Plants in sugar	1. 0.981	7.6	0.0161	1.64
	2. „	7.6		
Control plants	1. 0.978	9.7	0.0208	2.13
	2. „	9.7		

ASPARAGINE NITROGEN.

	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen ($\frac{1}{2}$ asp. nitrogen).
	Gram.	c. c.	Gram.	
Plants in suger	1. 1.962	1.0	0.0021	0.11
	2 „	1.1		
Control plants	1. 1.956	2.1	0.0047	0.24
	2. „	2.3		

(1) 1 *c.c.* baryta solution = 0.002148 gram nitrogen.

NITRATE NITROGEN.

	Dry matter used.	Pressure.	Temperature.	Volume of NO. gas.	Nitrogen found.	Percentage of nitrogen.
	Gram.	Inch.	°c.	c. c.	Gram.	
Plants in sugar...	1. 0.981	...	...	...	...	0
	2. „	...	...	...	...	0
Control plants ...	1. 0.978	29.7	16	2.7	0.0016	0.16
	2. „	„	„	2.8		

WHEAT (I).

ASPARGINE NITROGEN.

Plants in	Dry matter used.	Baryta water(1) replaced.	Nitrogen found.	Percentage of nitrogen ($\frac{1}{2}$ Asp. nitrogen).
	Gram.	c. c.	Gram.	
Ammonium phosphate	1. 1.866	1.7	0.0039	0.21
	2. „	1.9		
Sodium nitrate	1. 1.836	2.0	0.0045	0.24
	2. „	2.1		
Control plants	1. 1.890	1.4	0.0030	0.16
	2. „	1.4		

(1) 1 *c.c.* baryta solution = 0.002148 gram nitrogen.

WHEAT (II).

TOTAL NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Ammonium chloride...	1. 0.472	9.7	0.0206	4.48
	2. „	10.1	0.0217	
Ammonium carbonate	1. 0.467	9.7	0.0206	4.51
	2. „	10.0	0.0215	
Urea	1. 0.465	10.1	0.0217	4.63
	2. „	10.0	0.0215	
Sodium nitrate	1, 0.465	10.1	0.0217	4.60
	2. „	9.8	0.0211	
Control plants	1. 0.476	8.4	0.0180	3.73
	2. „	8.2	0.0176	
Original plants	1. 0.484	8.5	0.0183	3.72
	2. „	8.3	0.0178	

ALBUMINOID NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Ammonium chloride	1. 0.944	7.0	0.0151	1.64
	2. „	7.2	0.0155	
Ammonium carbonate	1. 0 933	7.4	0 0160	1.73
	2. „	7.5	0.0161	
Urea	1. 0.930	8.4	0.0180	1.96
	2. „	8.6	0.0185	
Sodium nitrate	1. 0.929	8.5	0.0183	1.99
	2. „	8.7	0.0187	
Control plants	1. 0.952	8.0	0.0172	1.81
	2. „	8.0	0.0172	
Original plants	1. 0.968	9.0	0.0192	1.98
	2. „	8.9	0.0190	

(1) 1 *c.c.* of the baryta solution = 0.002148 gram nitrogen.

ASPARAGINE NITROGEN.

Plants in	Dry matter used.	Baryta water(1) replaced.	Nitrogen found.	Percentage of nitrogen ($\frac{1}{2}$ Asp. nitrogen).
	Gram.	c. c.	Gram.	
Ammonium chloride	1. 1.888	6.6	0.0140	0.74
	2. „	6.4		
Ammonium carbonate	1. 1.866	5.6	0.0125	0.67
	2. „	5 9		
Urea	1. 1.860	6.6	0.0144	0.77
	2. „	6.7		
Sodium nitrate	1. 1.858	5.0	0.0105	0.57
	2. „	4.7		
Control plants	1. 1.904	4.5	0.0095	0.50
	2. „	4.3		
Original plants	1. 1.936	1.2	0.0028	0.14
	2. „	1.4		

NITRATES NITROGEN.

Plants in	Dry matter used	Height of barometer.	Tempera-ture.	Volume of NO. gas.	Nitrogen found.	Percentage of nitrogen.
	Gram.	(Inch.)	°c.	c. c.	Gram.	
Sodium nitrate...	1. 0.929	30.2	15°c	3.2	0.0020	0.21%
	2. 0.929	30.2	15°c	3.4		

(1) 1 *c.c.* baryta solution = 0 002148 gram nitrogen.

BARLEY (I).

TOTAL NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Sugar	1. 0.467	11.5	0.0215	4.60
	2. „	11.5		
Urea	1. 0.460	13.6	0.0260	5.65
	2. „	14.0		
Urea and sugar.....	1. 0.465	12.4	0.0232	4.98
	2. „	12.2		
Ammonium chloride	1. 0.470	14.1	0.0270	5.73
	2. „	14.4		
Ammonium chloride and sugar	1. 0.459	12.1	0.0230	5.00
	2. „	12.3		
Control plants	1. 0.4705	12.7	0.0239	5.10
	2. „	12.7		
Original plants	1. 0.477	12.9	0.0245	5.13
	2. „	13.1		

(1) 5 *c.c.* standard sulphuric acid were equivalent to 36.5 *c.c.* baryta solution and yielded 0.5695 gram barium sulphate. Hence 1 *c.c.* baryta solution = 0.001883 gram nitrogen.

ALBUMINOID NITROGEN.

Plants in	Dry matter used.	Baryta water(1) replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Sugar	1. 0.467	2.2	0.0069	1.47
	2. „	2.2		
Urea	1. 0.460	2.1	0.0069	1.50
	2. „	2.3		
Urea and sugar.....	1. 0.465	2.0	0.0065	1.39
	2. „	2.2		
Ammonium chloride	1. 0.470	2.3	0.0075	1.60
	2. „	2.4		
Ammonium chloride and sugar	1. 0.459	1.8	0.0056	1.23
	2. „	1.8		
Control plants	1. 0.471	2.7	0.0087	1.86
	2. „	2.9		
Original plants	1. 0.954	6.5	0.0206	2.16
	2. „	6.6		

(1) 1 *c c.* of the baryta solution = 0.0031245 gram nitrogen.

ASPARAGINE NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen ($\frac{1}{2}$ asp. nitrogen).
	Gram.	c. c.	Gram.	
Sugar	1. 0.634	4.7	0.0090	0.97
	2. „	4.9		
Urea	1. 0.920	4.6	0.0087	0.95
	2. „	4.7		
Urea and sugar.....	1. 0.930	5.2	0.0100	1.08
	2. „	5.4		
Ammonium chloride	1. 0.940	8.0	0.0151	1.60
	2. „	8.1		
Ammonium chloride and sugar	1. 0.918	5.0	0.0096	1.05
	2. „	5.2		
Control plants	1. 0.941	4.6	0.0087	0.92
	2. „	4.6		
Original plants	1. 0.954	2.2	0.0044	0.46
	2. „	2.4		

NITRATE NITROGEN.

Plants in	Dry matter used.	Height of Barometer.	Tempera-ture.	Volume of NO gas.	Nitrogen found.	Percentage of nitrogen.
	Gram.	Inch.	°C.	c.c.	Gram.	
Sugar	0.934	29.8	18	5.5	0.0032	0.35
Urea	0.920	29.9	16	7.7	0.0045	0.49
Urea and sugar	0.400	29.8	18	1.6	0.0009	0.24
Amm. chloride...	0.940	30.12	18	4.4	0.0026	0.28
Amm. chloride and sugar.....	0.918	30.12	19	3.5	0.0021	0.23
Control plants ...	0.941	30.12	18	5.8	0.0034	0.37
Original plants...	0.954	30.12	16	9.2	0.0055	0.58

(1) 1 *c.c.* baryta solution = 0.001883 gram nitrogen.

BARLEY (II.)

TOTAL NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Urea	1. 0.474	9.2	0.0291	6.10
	2. „	9.4		
Sodium nitrate	1. 0.474	8.6	0.0269	5.64
	2. „	8.6		
Urea and sugar.....	1. 0.476	9.0	0.0284	5.98
	2. „	9.2		
Original plants	1. 0.467	6.8	0.0215	4.60
	2. „	7.0		

ALBUMINOID NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen.
	Gram.	c. c.	Gram.	
Urea	1. 0.474	2.3	0.0072	1.52
	2. „	2.3		
Sodium nitrate	1. 0.474	2.2	0.0072	1.52
	2. „	2.4		
Urea and sugar.....	1. 0.476	2.4	0.0075	1.58
	2. „	2.4		
Original plants	1. 0.467	2.1	0.0069	1.47
	2. „	2.3		

(1) 1 *c.c.* baryta solution = 0.0031245 gram nitrogen.

ASPARAGINE NITROGEN.

Plants in	Dry matter used.	Baryta water[1] replaced.	Nitrogen found.	Percentage of nitrogen ($\frac{1}{2}$ asp. nitrogen.)
	Gram.	c. c.	Gram.	
Urea	1. 0.947	4.5	0.0141	1.49
	2. „	4.6		
Sodium nitrate	1. 0.948	3.5	0.0112	1.19
	2. „	3.7		
Urea and sugar.....	1. 0.952	4.1	0.0131	1.38
	2. „	4.3		
Original plants	1. 0.934	2.9	0.0090	0.97
	2. „	2.9		

NITRATES NITROGEN.

Plants in	Dry matter used.	Height of Barometer.	Tempera-ture.	Volume of NO gas.	Nitrogen found	Percentage of nitrogen.
	Gram.	Inch.	°C.	c. c.	Gram.	
Urea	0.947	29.8	18	3.8	0.002233	0.24
Sodium nitrate...	0.948	30.12	16	8.4	0.005023	0.53
Urea and sugar	0.952	29.8	18	4.0	0.002350	0.25
Original plants...	0.952	29.8	18	5.5	0.003232	0.35

(1) 1 *c.c.* baryta solution = 0.0031245 gram nitrogen.

Can Old Leaves of Plants Produce Asparagine by Starvation?

BY

T. Miyachi, *Nōgakushi.*

It has been asserted that only young plants or growing parts of plants, as germinating seeds or buds, can produce asparagine by decomposition of proteids.

As it seemed to me of some interest to test the validity of this assertion, I selected, on the 1st October, some old leaves of *Pæonia albiflora*, which by some brown spots clearly showed incipient decay.

A portion was directly dried at 100° C, and served for the determination of total nitrogen, protein nitrogen, and asparagine nitrogen. On the same day, another portion was very loosely placed in a glass vessel, containing a little water, and covered by a glass plate. From time to time fresh air was introduced.(1)

The microscopical examination, repeatedly carried on, revealed a gradual disappearance of the starch granules from the mesophyll (the epidermis cells were free from it at the beginning), and also a gradual decrease of the active albumin, stored up in the vacuoles, as the test, made with caffeine, indicated.(2)

On the 15th October, the leaves were dried, all brown dead portions being first removed. Active albumin was still present in the healthy parts, although in much smaller quantity than at the beginning; but soluble passive albumen could not be found.(3)

The results were as follows:—

	Fresh leaves.	Starved leaves.
Total nitrogen.	1.364%	1.462%(4)
Protein nitrogen.	1.312	0.801

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(1) The mean temperature was 17.68° C; the maximum 25.4°, and the minimum 11° C.

(2) Cf. this Bulletin vol. II. No. 2 and 4.

(3) I crushed some of the leaves with some water, filtered and heated the filtrate with a little nitric acid, but no precipitate was obtained.

(4) From this relative increase of nitrogen, it follows that 6.70 per cent of the original dry matter were consumed in the respiration process.

	Fresh leaves.	Starved leaves.
Asparagine nitrogen.	0.037	0.206
Amido-nitrogen except asp. nitrogen.	0.015	0.455

In 100 parts of total nitrogen.

	Fresh leaves.	Starved leaves.
Protein nitrogen.	96.19	54.79
Asparagine nitrogen.	2.71	14.09
Amido-nitrogen except asp. nitrogen.	1.10	31.12

We observe, therefore, the proportion between asparagine nitrogen in fresh leaves and that in starved leaves is 1 : 5.2.[1]

The second experiment was made with tea leaves.

On the 19th October I collected old leaves of *Thea chinensis* for the determination of total nitrogen, protein nitrogen, and asparagine nitrogen. At the same time numerous small branches (about 10 cm. long), taken from the same individual plant, were placed in a large vessel containing some fresh water, which was placed in the dark for 24 days[2] (Oct. 19th to Nov. 12th). All the young leaves had been first removed. While the branches were kept in darkness, the water in the vessel was renewed several times.

Microscopical examination repeatedly made, revealed, as usual, the gradual disappearance of the starch granules and the decrease of *active* albumin, which was present in large quantity at the beginning. Soluble *passive* albumin was not present at all, as the test of the cold aqueous extract with nitric acid showed.

Since some leaves commenced to show brown spots, on the 12th November and further exposure was likely to end soon in the death of all the leaves, I dried the still healthy ones, and subjected them to the same examination as the control leaves at the beginning.

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(1) *Young* leaves of this plant, collected in May, contained according to *Daikuhara* (Bull. Coll. of Agr. II. No. 2) 2.222% total nitrogen, and 2.648% after 25 days' starvation by being kept at 25°—30°C in darkness in a covered glass vessel containing some water, hence the loss by respiration amounts to 16.09% in 25 days which when calculated to 15 days become 9.65%. The intensity of respiration in these *young* leaves was therefore about one and half times as much as in the *old* leaves. The asparagine nitrogen was there at the beginning 9.86% of the total nitrogen ; after 25 days, however, it became 45.73%. The proportion between asparagine nitrogen in fresh leaves and in starved leaves was there 1 : 4 6.

(2) The mean temperature was 13.31°C, the maximum 23.7.C. and the minimum 3.2°C.

The result was as follows :

	In 100 parts of dry matter ; Fresh leaves.	Starved leaves.
Total nitrogen.	3.475%	3.987%[1]
Protein nitrogen.	2.850	2.511
Asparagine nitrogen.	0.201	0.867
Theine nitrogen.	0.283	0.358
Amido-nitrogen except asp. nitrogen.	0.141	0.251

	In 100 parts of total nitrogen. Fresh leaves.	Starved leaves.
Protein nitrogen.	82.01	62.98
Asparagine nitrogen.	5.78	21.75
Theine nitrogen.	8.14	8.98
Amido-nitrogen except asp. nitrogen.	4.07	6.29

We observe, therefore, the proportion between asparagine nitrogen in fresh leaves and that in starved leaves to be 1 : 3.7.[2]

My investigation, therefore, places it beyond doubt, that *even old leaves can produce asparagine from proteids.*

Some additional remarks may be made in regard to the behaviour of theine in the metabolism of plant cells.

In order to decide whether theine could be utilized as a source of nitrogen and carbon for the formation of proteids, I prepared 50$^{c.c.}$ of a solution containing 0.5% theine, 0.1% dihydropotassium phosphate and 0.01% magnesium sulphate, sterilised it, and infected it with spores of *Aspergillus orizae.* After standing from the 8th May to the 18th June, only a very small amount of mycelium covered with some spores, had developed.[3]

In a second case the solution was infected with *Penicillium glaucum ;* but no development was here observed.

Now, if theine proves to be such a poor nutrient for lower fungi, which possess great chemical energy, it may safely be inferred that it will also fail to be a nutrient for tea-leaves. Indeed its quantity is *increased* by the decomposition of proteids, as not

(1) From this relative increase of nitrogen it follows that 12.84 per cent of the dry matter was consumed in the respiration process.

(2) The high percentage of fatty matter present in tea leaves is evidently the reason why the decomposition of proteid and consequently the formation of asparagine was less energetic than in *Paeonia* leaves.

(3) On shaking the solution with chloroform and evaporating, a considerable quantity of crystallized theine was again obtained, easily identified by the principal reactions.

only the above analysis but also the following placed beyond doubt.

Old leaves of *Thea chinensis*, were analysed again both in the fresh and in the starved condition. Small branches were kept in water from the 23rd May to the 8th June at 19—23° C. in a covered vessel in darkness.

The analytical results were as follows :—

	Fresh leaves.	Starved leaves.
Total nitrogen.	2.575%	3.187%
Protein nitrogen.	2.149%	2.179%
Theine nitrogen.	0.288%	0.438%
Amido-nitrogen.	0.139%	0.570%

The relative increase of *total nitrogen* from 2.575% to 3.187% indicated that 19.21% carbohydrate, fat, and perhaps some carbon and hydrogen from the decomposed proteids, had been consumed by respiration.

A correct judgement can, of course, be obtained only when the amount of theine-nitrogen in both cases is compared with that of total nitrogen, which we may assume as a constant quantity in both cases ; thus we obtain for 100 parts of total nitrogen 11.15 of theine-nitrogen in the fresh leaves, and 13.74 in the starved leaves. Assuming that no loss of carbon and hydrogen by respiration had taken place, we obtain for the same amount of leaf-weight, i.e., for 0.996 gram. of theine in the original leaf, 1.227 grams of theine in the starved leaf, showing that *no consumption of theine had taken place* by starvation ; *on the contrary an increase is evident.*

This result, compared with the observation on fungi above mentioned, makes it highly probable that theine cannot be considered as a valuable nutrient.[1] It remains now to be seen, whether *in presence of much carbhydrate* and *absence of any other suitable source of nitrogen*, theine (caffeine) can be used as a source of nitrogen for building up proteids in tea leaves.

Analytical Data.

In the following analyses, the total nitrogen was determined by *Kjeldahl's* method, the protein nitrogen by that of *Stutzer*, and the asparagine by that of *Sachsse*, while theine by that of *Mulder*.

(1) This inference agrees with the observations of *Errera*, *Maistriau*, and *Clautriau* on the behaviour of alkaloids during germination (Bull. Soc. Belge de Microscopie, 1894).

I. *Pæonia albiflora.*

Total nitrogen in fresh leaves.

a). 1.8416 g. of dry matter contained 0.02512 g. of nitrogen (=13.4$^{c.\,cm.}$ baryta water[1]) equivalent to 1.364%. b). 1.8416 g. of dry matter contained 0.02512 g. of nitrogen (=13.4$^{c.\,c.}$ baryta water) equivalent to 1.364% ; average 1.364%.

Protein nitrogen in fresh leaves.

a). 1.8416 g. of dry matter contained 0.02407 g. of nitrogen (=12.84$^{c.\,c.}$ baryta water)=1.307%. b). 1.8416 g. of dry matter contained 0.02426 g. of nitrogen (= 12.94$^{c.\,cm.}$ baryta water) =1.397%, average 1.312%.

Asparagine nitrogen in fresh leaves.

a). 4.604 g. of dry matter contained 0.000937 × 2[2]=0.001874 g. of nitrogen(=0.5 × 2=1.$^{c.\,c.}$ baryta water)=0.0407%. b). 4.604 g. of dry matter contained 0.007490 × 2=0.001498 g. of nitrogen (=0.4 × 2=0.8$^{c.\,c.}$ baryta water)=0.0325%. Average 0.0366%.

Total nitrogen in starved leaves.

a). 1.8584 g. of dry matter contained 0.02719 g. of nitrogen (=14.5$^{c.\,c.}$ baryta water)=1.462%. b). 1.8584 g. of dry matter contained 0.02719 g. (=14.5$^{c.\,c.}$ baryta water)=1.462% ; average. 1.462%.

Protein nitrogen in starved leaves.

a). 1.8584 g. of dry matter contained 0.015074 g. of nitrogen (=8.04$^{c.\,cm.}$ baryta water)=0.811%. b). 1.8584 g. of dry matter contained 0.014700 g. (=7.84$^{c.\,cm.}$ baryta water)=0.790 ; average 0.801%.

Asparagine nitrogen in starved leaves.

a). 4.646 g. of dry matter contained 0.004875 × 2=0.009750 g. of nitrogen (=2.6 × 2=5.2$^{c.\,c.}$ baryta water)=0.209%. b). 4.646 g. of dry matter contained 0.004687 × 2=0.009374 g. (=2.5 × 2=5$^{c.\,c}$ baryta water)=0.203% ; average 0.206%.

II. *Thea chinensis* (*a*).

Total nitrogen in fresh leaves. (Nov. 1895).

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(1) 10$^{c.\,cm.}$ of the standard sulphuric acid contained 0.237548 g. of sulphuric acid and corresponded to 0.067873 g. of nitrogen ; 10.$^{c.\,cm.}$ of the sulphuric acid corresponded to 36.2$^{c.\,cm.}$ of baryta water. 1$^{c.\,cm.}$ baryta water=0.001875 g. of nitrogen.

(2) A molecule of asparagine contains two atoms of nitrogen and as by boiling it with hydrochloric acid only one atom is split off as ammonia, the result must be doubted.

a). 1.8182 g. of dry matter contained 0.063372 g. of nitrogen (=33.8$^{c.c.}$ baryta water)=3.485%. b). 1.8182 g. of dry matter contained 0.062997 g. (=33.6$^{c.c.}$ baryta water)=3.465% ; average 3.475%.

Protein nitrogen in fresh leaves.

a). 1.8182 g. of dry matter contained 0.05182 g. of nitrogen (=27.64$^{c.c.}$ baryta water)=2.850%. b). 1,8182 g. of dry matter contained 0.05182 g. (=27.64$^{c.c.}$ baryta water)=2.850% ; average 2.850%.

Asparagine nitrogen in fresh leaves.

a). 9.0910 g. of dry matter contained 0.0091670 × 2=0.018334 g. of nitrogen (=4.9 × 2 = 9.8$^{c.c.}$ baryta water) = 0.202%. b). 9.0910 g. of dry matter contained 0.009000 × 2=0.018000 g. (=4.8 × 2=9.6$^{c.c.}$ baryta water)=0.199% ; average 0.201%.

Theine nitrogen in fresh leaves.

a). 4.5455 g. of dry matter yielded 0.046 g. theine(=0.013278g. theine-nitrogen)=0.292% nitrogen. b). 4.5455 g. of dry matter yielded 0.043 g. theine (=0.01241 g. theine-nitrogen)=0.273% nitrogen ; average 0.283% nitrogen.

Total nitrogen in starved leaves.

a). 1.81730 g. of dry matter contained 0.072586 g. nitrogen (=38.7$^{c.c.}$ baryta water)=3.992 %. b). 1.81730 g. of dry matter contained 0.072371 g. (=38.6$^{c.cm.}$ baryta water)=3.983% nitrogen.

Protein nitrogen in starved leaves.

a). 1.81730 g. of dry matter contained 0.045823 g. nitrogen (=24.44$^{c.c.}$ baryta water)=2.521%. b). 1.81730 g. of dry matter contained 0.045448 g. (= 24.24$^{c.c.}$ baryta water) = 2.501 %; average 2.511 %.

Asparagine nitrogen in starved leaves.

a). 4.54325 g. of dry matter contained 0.00394 × 2=0.00788 % nitrogen (= 10.5 × 2 = 21. c. c. baryta water) = 0.8666 %. b). 4.54325 g. of dry matter contained 0.00394 × 2=0.00788 g.=(10.5 × 2=21. c. cm. baryta water) = 0.8666 % ; average 0.8666 % nitrogen.

Theine nitrogen in starved leaves.

a). 4.54325 g. of dry matter yielded 0.058 g. theine (=0.016742 g. theine nitrogen.)=0.368% nitrogen. b). 4 54325 g. of dry matter yielded 0.055 g. theine (=0.015777 g. theine nitrogen)=0 348 % nitrogen average 0.358 % of theine nitrogen.

II. *Thea chinensis* (b)[1]

Total nitrogen in fresh leaves.

a). 0.9435 g. of dry matter contained 0.0242983 g. of nitrogen (=14.2 c. c. baryta water[2])=2.575 %. b). 0.9435 g. of dry matter contained 0.0242983 g. (= 14.2 c. c. baryta water) =2.575 %; average 2.575 % nitrogen.

Protein nitrogen in fresh leaves.

a). 0.9435 g. of dry matter contained 0.0203627 g. of nitrogen (=11.9 c. c. baryta water)=2.158 %. b). 0.9435 g. of dry matter contained 0.020191570 g. (=11.8 c. c. baryta water)=2.140%. average 2.149 %, of protein nitrogen.

Theine nitrogen in fresh leaves.

a). 4.7175 g. of dry matter yielded 0.045 g. theine (=0.0130412 g. theine nitrogen (=0.276% nitrogen. b). 4.7175 g. of dry matter yielded 0.049 g. theine (=0.0141958 g. nitrogen) =0.301%; average 0.288 % theine nitrogen.

Total nitrogen in starved leaves.

a.) 0.8951 g. of dry matter contained 0.0285762 g. of nitrogen (=16. c. c. baryta water)=3.192 %. b). 0.8951 g. of dry matter contained 0.0284906 g. (=16.65 c. c. baryta water)=3.183 %; average 3.187 %.

Protein nitrogen in starved leaves.

a). 0.8951 g. of dry matter contained 0.0194216 g. of nitrogen (=11.35 c. c. baryta water)=2.169 % nitrogen. b).. 0.8951 g. of dry matter contained 0.0195927 g. (=11.45 c. c. baryta water) =2.189 %; average 2.179 %.

Theine nitrogen in starved leaves.

a). 4.4755 g. of dry matter yielded 0.0635 g. theine (=0.019195 g. theine nitrogen)= 0.428 % theine nitrogen. b). 4.4755 g. of dry matter yielded 0.0695 g. theine (=0.0200618 g. theine nitrogen)=0.448 % theine nitrogen; average 0.438 %.

---

(1) These old leaves were collected in May 1896.

(2) 10 c. cm. of the standard sulphuric acid corresponded to 21.6 c. cm. of the standard baryta water and 1. c. cm. of the baryta water corresponded to 0.00171115 g. of nitrogen.

On the Relative Value of Asparagine as a Nutrient for Phaenogams.

BY

T. Nakamura, *Nōgakushi.*

It has repeatedly been shown that asparagine and other amido-compounds applied to roots of plants are assimilated and can serve as valuable sources of nitrogen. But quantitative comparisons have not yet been carried out, which would no doubt be of great value ; above all it appeared desirable to compare the relative value of asparagine as a source of nitrogen with those of other closely related compounds. I made several experiments to obtain some light in this direction.

In my first experiment I compared the action of asparagine with ammonium succinate upon young barley plants, which were measured from the base of the stem to the tip of the plumula at different intervals. The solutions were prepared by mixing 2 % solutions of asparagine and of ammonium succinate with equal volumes of a saturated solution of gypsum.

After five days, the plants were placed for one day in another solution containing mono-potassium phosphate and magnesium sulphate (0.1 % of each).[1]

Twenty four plants were placed in narrow beakers containing 200 c.c. of these solutions and kept at a temperature of 12°—20°C. After four days, the plants in ammonium succinate solution commenced to show a yellow colouration on the tips and this colouration increased gradually so that on the tenth day all the leaves had turned yellow, but they were still alive as the full turgor was still preserved.

On the other hand, the plants in asparagine solution had remained green up to this time. The great difference in growth after nine days is seen from the following table :

---

(1) This separation of solutions is necessary to prevent bacterial growth, or to resist it as much as possible.

	Asparagine cm.	Ammonium succinate cm.
Average height, March 12th	20.27	19.92
,, ,, ,, 21th	22.60	20.33
Difference	2.33	0.41
Percentage of increase	11.49	2.06

In the next experiment, the solutions contained only one-fifth as much asparagine and ammonium succinate as before, all other conditions being the same. The result was after 14 days as follows :

	Asparagine cm.	Ammonium succinate cm.
Average height, March 23th	21.31	21.06
,, ,, April 6th	28.13	24.08
Difference	6.82	3.02
Percentage of increase	32.00	14.34

In the third experiment, onion plants were treated with the same solutions as in the first experiment, five plants being placed in each of the solutions, after all the side leaves had been cut off. Although in this case the central leaves in both solutions reached the same height, there was, nevertheless, a great difference in the number and length of the newly developed branches.[1]

PLANTS IN ASPARAGINE.

(1) The leaves kept in ammonium succinate solution commenced to show yellow colouration on the seventh day.

PLANTS IN AMMONIUM SUCCINATE.

Shaded branches are those newly developed.

Length of branches after 13 days.

Asparagine cm.		Ammonium succinate.(1) cm.	
10.0		14.5	
22.0		10.0	
9.0		23.5	
5.0	(with a flower.)	7.0	(with a flower.)
27.0		17.0	
6.0	(,, ,, ,,)	8.0	
19.0		23.0	
10.0		103.5	
7.0	(,, ,, ,,)		
25.0			
7.0	(,, ,, ,,)		
20.5			
167.5			

It thus appears that the total length of branches amounted to 50 % more with asparagine than with ammonium succinate.

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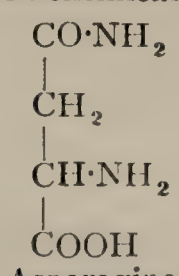
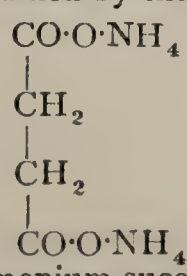
(1) The difference in chemical structure is explained by the following formulæ :



Asparagine



Ammonium succinate.

On the Relative Value of Asparagine as a nutrient for Fungi.

BY

T. Nakamura, *Nōgakushi.*

In order to arrive at a reliable judgement in regard to the value of asparagine for fungi as a material for production of proteids, it is necessary to offer it in conjunction with another organic material which is free from nitrogen and is able not only to supply a great deal of carbon which is necessary to form proteids from asparagine, but which also would easily support respiration and serve for the formation of cellulose. But such very favourable nutrients as glycerol or glucose have to be avoided, because these would somewhat obscure the relative value of the nitrogenous compounds inasmuch as they yield a very good result even with such simple nitrogenous compounds as ammonia. I selected therefore as less favourable material ethyl and methyl alcohol. The amount of nitrogenous and non-nitrogenous compounds was such that the number of carbon atoms was four times that of the number of nitrogen atoms. 500 c.c. of each solution were taken and sterilized by boiling before the alcohol was added.[1] The fungus used for these experiments was *Aspergillus orizae*. In order to distribute as closely as possible an equal number of spores upon the different flasks some spores were suspended in 10 c.c. sterilized water and after well shaking each time 1 c.c. was added to each solution. The flasks remained in a room whose temperature (from 27th January to 15th February) ranged between 5° and 15°C. The fungoid mass was collected after 18 days on a weighed filter and after being well washed, was dried at 100°C. The results were as follows :

---

(1) Each solution contained further 0.1 % monopotassium phosphate and 0.02 % magnesium sulphate.

TABLE I.

Nourishing material in grams. for 500 c. c.	Weight of fungus in grams.
Ammonium tartrate 6.33 + ethyl alcohol 3.06	0.015
„ malate 5.00 + „ „ „	0.011
„ succinate 5.00 + „ „ „	0.008
„ lactate 7.13 + „ „ „	0.006
„ acetate 5.13 + „ „ „	0.000
„ nitrate 2.66 + „ „ „	0.002
Asparagine 5.00 + „ „ „	0.026
„ 5.00 alone	0.016

Second experiment.

Here methyl alcohol was applied in addition to the nitrogenous materials which were asparagine, glycocoll, urea, betaïn, ammonium chloride, sodium nitrate, ammonium tartrate, ammonium malate, and ammonium succinate. All the solutions contained 1 % methyl alcohol, while the sources of nitrogen were applied in such proportion that the number of nitrogen atoms to those of carbon showed the ratio of 1 : 8. This time the amount of monopotassium phosphate was increased to 0.5 % and to all the flasks ferrous sulphate,(1) sodium sulphate, and magnesium sulphate (0.1 % of each) were added. All other conditions were the same as before except that the volume of the solutions was only 200 c.c. and the temperature somewhat higher, ranging from 9°—19°C. The flasks, after two weeks, exhibited a considerable difference; in betaïn, ammonium succinate and ammonium malate, no fungoid development was yet noticed(2); in ammonium tartrate only a moderate quantity was observed, much however in asparagine and glycocoll. The flasks had been frequently shaken in order to prevent the formation of spores on the surface which would have again given rise to a great increase of the mycelium. Only during the last 4 days shaking was dispensed with, allowing now spores to

(1) Certain fungi are only developed in presence of iron salts (*Molisch*) ; according to *Raulin* also presence of zinc salts will promote the development of mould fungi.

(2) They were infected again and left to stand for several months, whereupon a moderate development was observed.

be formed, the solutions containing asparagine and glycocoll then showed more spore development than the other nutrients.

TABLE II.

Nutrient in gram for 200 c.c. solution	Weight of fungoid mass in grams.
Ammonium tartrate 0.79 + methyl alcohol 2 g.	0.012
„ chloride 0.42 + „ „ „	0.025
Sodium nitrate 0.66 + „ „ „	0.015
Urea 0.25 + „ „ „	0.028
Glycocoll 0.79 + „ „ „	0.063
Asparagine 0.78 + „ „ „	0.073
„ „ „ without methyl alcohol	0.047

Summary.

It is seen from these two experiments that for mycelium fungi asparagine is a superior source of nitrogen, even far superior to such a closely related compound as ammonium succinate. Protein-production must then be much more easily possible from the former than from the latter, *i.e.*, the way from asparagine to proteid is much shorter than that from ammonium succinate although this is so closely related to asparagine. This conclusion holds good also for phænogams as shown above.

On the Quantities of Nitrates Stored up in Plants under Different Conditions.

BY

T. Ishizuka, *Nōgakushi.*

The amount of nitrates stored up in plants varies not only in different parts of the same plants, but it is subjected to great variation in the entire plants, which depends on the one hand upon the relative amount of nitrates present in a soil and on the other upon the state of development of plants, as, e.g., by rapid development of plants all the nitrates, otherwise deposited in stem and root, would be utilized for the formation of proteid.

I suspected, however, that, by gradual reduction, the amount of nitrates would also decrease *on keeping objects, especially roots, for several months in a cool place.*

A series of qualitative tests with diphenylamine and sulphuric acid was first made to acsertain which objects are rich in nitrates; this reaction failed, however, with the roots of *Batatas edulis, Nelumbo nucifera, Lilium tigrinum, Solanum tuberosum, Helianthus tuberosus, Capsicum longum, Eutrema Wasabi, Colocasia antiquorum,* and with the fruit of *Cucurbita Pepo.* The quantitative determinations of nitrates were always made with fresh objects, which were cut into small pieces and extracted with water on a water-bath for half an hour; the residue obtained by the evaporation of the filtrate was then extracted with alcohol of 60 %; this extract after evaporation to dryness served for the determination of nitrates by the method of *Tieman* and *Schulze.*[1]

The results are shown in the following table A.

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(1) In some of the objects the qualitative test already revealed a decrease of nitrates and in some cases an entire disappearance after several months, as in a variety of *Allium fistulosum.* On the other hand no decrease was observed with the root of *Lappa major*, kept from 9th October to 4th Nov., but here the examination showed at once that the cells of the roots had died off.

	Objects.	Date of analysis.	Nitric anhydride in 100 parts of dry matter.
Fruits.	*Solanum Melongena*.....	Sept. 21. Sept. 30.	0.13 0.11
	Benincosa cirifera	Oct. 24. Nov. 28.	0.78 0.52
Isolated roots.	*Daucus Carota*.....	Oct. 19. Oct. 31.	0.11 0.06
	Allium fistulosum.....	Oct. 3. Nov. 9.	1.35 0.17
	Raphanus sativus.....	Nov. 22. Febr. 24. Apr. 7.	3.25 2.85 2.50
	Brassica campestris.....	Nov. 22. Febr. 29.	1.16 0.90
Leaves and stems.	*Brassica oleracea* (sprouts).....	Nov. 9. Nov. 31.	1.00 0.95
	Raphanus sativus	Sept. 24. Oct. 21.	4.14 2.44
	Brassica campestris	Sept. 24. Oct. 21.	2.81 2.12

From this table it becomes quite evident that the amount of nitrates in the different cases decreases more or less on keeping the objects.

I directed my attention further to the amount of nitrates found in the same plants at different seasons, especially in such plants, as serve generally as food, viz., the root of *Raphanus sativus* and *Brassica campestris*, commencing the determination

in October and *taking samples from the field from time to time. The differences here found were not so large as in the other case, where the objects were kept in a state of rest after they had been harvested.*

Object. Root of	Dates of collection.	Nitric anhydride in 100 parts of dry matter.
Raphanus sativus.....	15 Oct	4.80
„ „	21 „	4.13
„ „	28 „	4.77
„ „	4 Nov.	5.16
„ „	13 „	4.06
„ „	25 „	3.25 (1)
„ „	9 Dec.	2.50
„ „	20 „	3 34
„ „	27 Jan.	2.66
„ „	12 Feb.	3.50
„ „	10 March.	2.21
„ „	29 Apr.	3.95 (2)
„ „	22 May.	3.70

Object. Root of	Dates of collection.	Nitric anhydride in 100 parts of dry matter.
Brassica campestris.....	21 Oct.	2.27
„ „	28 „	2.45
„ „	4 Nov.	2.36
„ „	18 „	2.44
„ „	9 Dec.	0.67
„ „	20 „	1.06
„ „	27 Jan.	1.09
„ „	12 Feb.	1.21

(1) Frost had set in.

(2) This determination was made with a young plant.

I paid also some attention to the products of transformation of the nitrates. If all conditions are favourable, then of course the nitrates are assimilated in the building up of proteids; if, however, all conditions for this process are not fulfilled other products might be formed and I suspected above all a gradual transformation into asparagine in such cases. To compare the amounts of nitrates and asparagine in the roots of *Raphanus*, *Brassica* and *Daucus* three determinations were made: first just after they had been harvested, then after being kept for sixty days in the dark in moist saw dust at the ordinary temperature, and again forty days later.

Objects.	Dates of examination.	In dry matter.	
		Percentages of nitric anhydride.	Percentages of asparagine.
Raphanus sativus.....	22 Nov.	3.25	4.35
	24 Feb.	2.85	5.66
	7 Apr.	2.56	6.18
Daucus Carota	22 Nov.	0.048	5.47
	24 Feb.	...	6.44
	7 Apr.	0.046	7.41
Brassica campestris	22 Nov.	1.16	6.20
	24 Feb.	0.90	10.35

We here indeed observe a gradual decrease of nitrates and increase of asparagine, but the latter increased so much more that we must assume the larger *portion of the asparagine was produced either by decomposition of proteids or by the transformation of other nitrogenous organic compounds.*

On the Significance of the Nitrates Contained in Plants for Animals and Men.

BY

T. Ishizuka, *Nōgakushi.*

As the presence of nitrates in the food is of more influence upon the well-being of animals and men than is often supposed, it is well to discuss such circumstances as relate to the amount of stored up nitrates in plants ; these are principally :

a). Intensity of nitrification in the soil.

b). The amount of rain removing the nitrates from the soil.

The amount of nitrates formed in the soil depends, of course, above all upon the amount of ammonia present ; in the second place upon the condition of the soil.

Dehérain noticed a great influence of the kind of soil upon the intensity of nitrification : a porous soil formed more than double as much of nitrate as a less porous one ; a clayey soil would admit less aëration, therefore would be also less favourable for nitrification (Ann. Agronom. **21**, 353, 1895).

In the third place the development of the microbes of nitrification (Nitrosomonas and *Nitromonas*) depend not only upon climate, and *mechanical* condition of the soil, but also upon the presence of certain *chemical* compounds ; thus it was found by *Dumont* that the increase of potassium salts in a soil and the simultaneous presence of humus and calcium carbonate favour the development of the nitrifying microbes, and therefore the production of nitrites from ammonia which very soon pass into nitrates in the soil.

Furthermore, the amount of rain must have a great influence upon the amount of nitrates, as these are not absorbed by the soil. Heavy rains combined with thorough drainage of the field therefore deprive the soil well nigh completely of the nitrates present. On the other hand, frequent small showers will merely promote the energy of nitrification, and a larger amount of nitrates will accumulate, because of the rain water in this case not *draining* away, but simply *evaporating* again from the soil.

Moreover, shallow soils are more easily deprived of the nitrates by the same amount of rain than deep soils; and finally a great influence will be exerted by the temperature, as in summer the nitrification is more intense than in winter. Thus we observe a *local* and *temporal* influence upon the amount of nitrates present in the soil, and the great differences *Berthelot*[1] observed in regard to the quantity of nitrates in plants thus finds a simple explanation.

Countries with regular and copious summer rains will show also less nitrates in the plants than countries with rather dry summers, while again in desert-soils nitrates are not found at all, because of no bacillus being able to thrive in the absence of water.

The noxious qualities of vegetable food, rich in nitrates, for animals have been recognized by *Lawes* and *Gilbert*, the illustrious investigators of Rothamsted, England. I quote from the lecture of *Henry Gilbert* delivered in America in Nov. 1893 the following passage:

> "Then, again, as generally more or less of the nitrogen in root will exist as nitrate, it will so far not only have no food value, but it may be *positively injurious*. It may be added that, other things being equal, the higher the percentage of nitrogen in roots the lower, as a rule, will be the proportion of it as albuminoids, and the higher that as amides and as nitrate, etc. Further in direct experiments at Rothamsted with sheep feeding on roots alone, it was found that while the animals even gained in weight on *ripe* roots, *low* in nitrogen, they actually *lost* on roots that were *less ripe*, *high in nitrogen*, and doubtless containing a larger proportion of their nitrogen as non-albuminoid compounds."

It is true that *nitrates by themselves* have not a very noxious effect on animals as it requires about 2.5 g. of potassium nitrate for 1 kilo of body-weight of an animal to bring on death, but there

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(1) *Berthelot* found that the amount of nitrates may vary from 0 to 15 % in potato, from 0 to 2.8 % o in wheat, from 0 to 15 % in *Amarantus*. (Chem Centralbl. 1884, 639).

The amount in turnips and beets was found to vary between 0.5 – 3.5 % of the dry matter (*Ebermayer*, Physiologische Chemie der Pflanzen).

exist numerous kinds of bacteria which can reduce the nitrates to the poisonous *nitrites* while other kinds of bacteria again reduce them directly to the less noxious ammonia.(1)

The dangerous character of nitrites is clearly elucidated by the observation of *Atkinson*, that 0.2 g. sodium nitrite produces heavy intoxication in men.(2) Guinea-pigs are killed by 0.5 g. of sodium nitrite no matter whether administered through the stomach or subcutaneously, under the phenomena of paralysis and kyanosis.

Of those bacteria which produce nitrites from nitrates, the bacillus of Cholera asiatica acts most energetically, and *Emmerich* and *Tsuboi* have therefore propounded the theory that the symptoms in cholera disease are due to the *nitrites formed by this bacillus in the intestines of men from the nitrates in food.*(3) Indeed, this theory explains thus far alone the *temporal, local* and *individual* disposition for cholera.(4) *Pettenkofer* pointed out that cholera in temperate zones makes its appearance as a great epidemic always late in summer or at the beginning of autumn, further that certain cities are never visited by this epidemic, and that *drinking water* has no influence upon the spread of cholera,(5) and inferred that there must exist a second principle besides the cholera bacillus to make the genuine cholera possible.

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(1) In this regard an observation made by *Richter* is of great interest ; he discovered nitrites in the urine in a case of acute affection (catarrh) of stomach and intestines, and elucidated further that the action of a coccus upon the nitrates of the food had given rise to the production of the poisonous nitrites. (Fortschritte. d. Med. 13. 478).

(2) Certain animals as rabbits require more to affect them seriously ; perhaps there exists conditions in them by which the nitrous acid is prevented from being set free so easily.

(3) Münch. Med. Wochenschr, 1893. That theory was attacked by *Klemperer* and *Pfeiffer*, but not disproved. By means of the reaction of *Gries*, nitrous acid would no doubt be discovered more often than formerly in the feces of cholera patients.

For the production of the cholera-red reaction indol is necessary, but as *Govini* (1893) has shown this is not formed in presence of much sugar and is absent sometimes in cholera-feces.

(4) *Semerad* came to the same conclusion as *Pettenkofer*, that besides meteorological conditions the soil has also great influence, as his investigations on the cholera-epidemic in *Jungbunzlau* left no doubt on this point.

(5) The nitrates are present, if at all, in too small quantities to be taken into account : thus, the sum of nitrous and nitric acid in 10,000 parts of drink water of Tokyo (1885) was found to be :

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0.002	0.004	0.158	0.173	0.211	0.128	0.156	0.163	0.162	0.152	0.110	0.009

He has also called attention to his observation, that great cholera epidemics appear in those years in which the rain fall of summer remains far below the average, which fact would appear very strange, if the cholera bacillus alone were the cause, as abundance of moisture would be most favourable to the development of that bacillus.[1] This fact as well as the gradual decrease of the epidemic towards winter,[2] and further its breaking out at the time when the new vegetables are harvested, is in best accordance with the theory of *Emmerich* and *Tsuboi*, for which my own investigations above described bring further support. Finally I must point out that the law, discovered by *Pettenkofer* in regard to the influence of rain, is also confirmed by the phenomena observed in Japan : I compared the intensity of the four cholera epidemics during the last 13 years with the amount of rain-fall from May to October, and from this it becomes evident that in those years in which the rain fall was considerably below the average, the epidemic was more serious than in those years in which the rainfall was more copious, as the following tables show :

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(1) I do not assert here that the nitrites produced are the *exclusive* poison in cholera. Indeed *Hüppe* and *Scholl* have discovered in cholera cultures also poisonous proteids. There exist cases of a milder form of cholera in which the formation of nitrites is not the leading factor, as, *e.g.*, also the cholera produced in Guinea-pigs by subcutaneous injections of comma bacilli. Cf. also the interesting article of *Hüppe*, Berl. Klin. Wochenschr. 1894. No. 17.

(2) *Montefusco* tries to explain this by the decreasing virulence in great cold, but this is not satisfactory, as cholera stops even in warm winters.

NAGASAKI. POPULATION 71,600.

Year.	Amount of Rain fall mm.						Absolute number of deaths from cholera.
	May	June	July	August	Sept.	Oct.	
1883	293.4	92.1	414.0	167.3	209.4	167.5	...
4	174.0	192.7	231.4	358.2	309.9	125.9	...
5	401.0	985.4	149.6	159.2	117.4(1)	50.2	2246
6	291.3	369.1	135.1	192.0	253.5(1)	182.1	1562
7	176.3	324.0	154.8	192.8	322.7	328.7	...
8	157.8	259.7	191.1	97.1	48.5	87.1	...
9	151.1	457.0	798.4	78.6	128.6	107.1	...
90	241.8	393.0	206.0	214.0	214.8	117.3	3544
1	233.6	298.9	255.3	203.3	207.6	116.4	...
2	163.1	338.9	52.0	250.6	53.3	145.4	...
3	218.0	319.5	35.0	476.8	350.1	252.2	...
4	70.2	43.7	110.4	25.3	152.8	26.2	...
5	83.2	337.0	216.0	27.9	114.2(1)		1203
Mean	204.5	347.0	288.3	190.2	190.9	141.7	

NAGASAKI.

	Temperature (Average). °Cels.					
	May	June	July	August	Sept.	Oct.
1883	17.7	21.6	25.7	27.0	22.7	19 5
4	17.1	21.0	25.6	25.6	24.1	16 8
5	18.2	21.7	25.1	27.4	24.1	18.7
6	18.2	21.6	26.0	27.1	23.3	19.0
7	17.6	21.1	26.1	26.6	23.6	19.1
8	18.4	20.9	26 2	27.8	23.4	17.7
9	18.1	23.2	26.0	26.9	22.5	17.8
90	18.7	22.5	26.7	26.5	24.9	18.2
1	18.3	21.8	25.5	26.6	25.2	19.2
2	18.1	22.2	27.4	27.5	24.4	17.6
3	18.5	21.6	27.9	26.8	25.4	...
4	17.8	24.5	27.8	29.1	24.3	18.5
5	17.4	21.3	24.1	27.6	24.3	17.6
Mean	18.0	21.9	26.1	27.1	23.5	18.3

(1) Epidemic most violent.

HIROSHIMA. POPULATION 94,300.

	Amount of Rain fall mm.						Absolute number of deaths from cholera.
	May	June	July	August	Sept.	Oct.	
1883	51.6	10.7	204.6	115.9	116.4	50.2	...
4	163.0	198.3	328.6	126.2	167.6	59.2	...
5	251.6	563.7	111.9	57.3	129.8	85.2	13
6	249.9	131.4	135.1	192.0(1)	253.5	191.1	5229
7	162.4	224.2	139.3	38.6	153.6	145.8	...
8	86.8	181.1	255.4	50.4	176.9	51.8	...
9	107.1	329.3	610.7	62.8	139.8	126.2	...
90	185.3	245,0	160.9	80.9	165.5(1)	99.0	1325
1	178.2	252.6	210.8	79.3	163.2	101.8	
2	227.9	275.8	92.4	34.4	110.4	121.4	
3	149.0	142 0	6.3	214.0	166.7	308.1	
4	78.0	139.7	153.5	66.3	328.4	12.4	
5		242.9	244.7	127.3	50.6	(1)	3049
Mean	165.9	225.9	203.4	95.7	163.2	112.7	

HIROSHIMA.

	Temperature (Average). °Cels.					
	May	June	July	August	Sept.	Oct.
1883	16.7	21.0	26.0	27.0	23.0	18.3
4	16.6	20.4	25.0	25.1	23.6	15.7
5	16.8	21.3	24.3	26.9	23.5	17.2
6	17.1	20.5	26.1	27.1	23.1	17.6
7	16.1	20.5	25.2	26.7	22.6	18.2
8	17.6	20.4	25.9	27 0	21.8	15.6
9	16.4	21.9	24.7	27.2	21.5	16.3
0	17.6	21.8	25.2	27.2	24.0	16.5
1	17.6	21.1	24.8	26.2	24.4	17.6
2						
3	16.0	20.1	26.9	27.0	24.2	16.4
4	16.9	23.7	27.4	27.4	22.9	17.1
5	18 7	22.4	25.3	27.6	24.1	18.6
Mean	16.9	21.2	25.6	26.9	23.2	17.0

(1) Epidemic most violent.

OSAKA-FU. POPULATION 490,000.

	Amount of Rain-fall mm.						Absolute number of deaths from cholera.
	May	June	July	August	Sept.	Oct.	
1883	17.7	6.4	107.9	84 6	121.9	71.2	
4	143.7	215.0	307.8	48.2	265.0	25.1	
5	96.8	867.4	112.2	26.7	65.9	166.1(1)	1095
6	204.5	144.9	8.6	24.0(1)	187,1	138.0	15968
7	86.8	211.1	73.3	98.6	97.2	221 4	
8	94.2	119.4	145.8	86.1	120.1	92.8	
9	89.9	165.8	231.3	193.8	156.5	163.0	
90	117.2	232.4	118.1	50.7	129.3(1)	154.1	7477
1	113.3	222.9	132.8	68 6	132.7	155.2	
2	189.6	262.6	169.4	59 0	168.8	143.1	
3	209 0	112.4	14.7	116 5	182.5	185 0	
4	41.1	97.1	95.1	81.7	109.3	84.0	
5	102.0	279.2	208.1	87.9	147.7		5315
Mean	115.8	228.2	131.1	78.9	144.9	133.2	

OSAKA.

	Temperature (Average). °Cels.					
	May	June	July	August	Sept.	Oct.
1883	16.5	21.3	26.2	26.7	22.7	17.6
4	16.8	21.0	25.2	25.4	23.4	15.5
5	16.7	21.9	25.1	27.3	23.9	17.9
6	17.4	21.8	26.7	27.6	23.7	18.0
7	16.3	21.2	25.7	27.2	22.8	18.6
8	18.0	20.4	26.3	27.3	22.6	16.1
9	16.4	22.3	25.2	27.1	21.6	16.3
90	17.9	22.7	25 8	27.2	25.0	17.0
1	18.3	21.3	25.6	26.5	25 0	16.6
2	16.7	22.0	27.0	27.2	24.5	17.0
3	16.6	20.7	27.5	27.4	24.6	17.1
4	17.5	24.1	28.2	28.4	23.4	16.4
5	18.2	21.5	24 4	27.8	23.8	17.4
Mean	17.2	20.9	26.2	27.1	22.9	17.8

(1) Epidemic most violent.

TOKYO-FU. POPULATION 1,342,000.

	Amount of Rain-fall mm.						Absolute number of deaths from cholera.
	May	June	July	August	Sept.	Oct.	
1883	92.4	199.0	90.8	111.9	135.4	163.5	...
4	134.9	177.5	102.9	90.5	193.2	78.6	...
5	77.2	331.0	182 6	103.2	72.0	296.9	112
6	164.1	80.5	48.5	87.1	254.6	190.9	9879
7	147.4	216.2	91.2	97.6	102.3	223.5	...
8	144.4	174.0	135.9	81.0	184.5	211.7	...
9	195.3	68.5	259.9	96.2	187.3	109.3	...
90	141.5	188.8	120.1	106.0	214.3(1)	198.0	3307
1	347.5	180.3	130.1	105.3	212.5	191.7	...
2	267.9	285.9	109.1	20.9	288.9	136.6	...
3	145.3	95.5	54.9	95.3	90.8	147.8	...
4	84.3	57.5	61.6	199.5	144.9	192.7	...
5		177.6	299.8	129.3	83.6(1)		2500
Mean.	145.1	171.7	109.0	101.8	166.4	178.0	...

TOKYO.

	Temperature (Average). °Cels.					
	May	June	July	August	Sept.	Oct.
1883	15.2	19.6	23.5	24.8	21.6	16.5
4	15.2	19.5	23.3	23.8	21.4	15.6
5	15.2	20.3	23.1	25.5	22.1	16.1
6	16.4	20.8	25.0	26.5	23.3	16.7
7	15.2	20 3	23.6	25.3	21.1	16.6
8	16.0	18.6	24.5	25.6	21 0	15.1
9	15.7	20.9	23.3	25.8	20.4	14 6
90	16.1	22.0	23.5	25 4	24.1	16.0
1	18.2	20.3	24.9	25.5	24.3	16.5
2	16.6	21.1	25.7	26.3	23.0	16.5
3	15.8	20.4	25.2	26.1	22.4	15.9
4	16.3	23.6	26.8	27.0	21.9	15.4
5	17.5	20.4	22.1	25.5	22.9	16.5
Mean	16.8	20.6	24.2	25.6	22.2	15.9

(1) Epidemic most violent.

The circumstance, that Japan has, as a rule, much rain in summer, may account for the fact that the cholera-epidemics, so frequent in Japan, rarely assume such frightful proportions as are observed in certain cities in Europe, as Munich, Hamburg, Marseilles, Naples or Palermo.

One of the violent epidemics in Japan was that of 1886 in Osaka and just in that summer the rains in June, July, and August were very far below the average, while they were much less so in the case during the three other milder epidemics of 1885, 1890 and 1895. The same rule holds good further for the epidemics in Tokyo, while in Nagasaki and Hiroshima the four epidemics reached but small dimensions, and here the meteorological tables again show that the average amount of rain in June, July, and August never sank so far below the average as was the case in the year 1886 in Osaka. We may therefore conclude that *Pettenkofer's* conclusions are confirmed by the observations in Japan.(1)

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(1) As in spring and summer of 1896 numerous and heavy rains fell in Tokyo, I predicted that a cholera-epidemic would not take place in the following autumn. And indeed during the months of August and September the number of cholera cases for every week were restricted to an average of three or four, gradually disappearing entirely in October. O. Loew.

On the Physiological Behaviour of Maleic and Fumaric acids.

BY

T. Ishizuka, *Nōgakushi.*

The stereo-isomeric fumaric and maleic acids,

$$\begin{matrix} HOOC-CH \\ \| \\ CH-COOH \end{matrix} \quad \text{and} \quad \begin{matrix} CH-COOH \\ \| \\ CH-COOH, \end{matrix}$$

show not only in chemical, but also in physiological respects highly interesting differences. Mould fungi can easily utilize fumaric acid as source of carbon for building up their protoplasm, but not maleic acid.[1] *Lœw*[2] found a similiar difference for bacteria; fumaric acid is an excellent nutrient, while maleic acid an exceedingly poor one.

Moreover, *Pfeffer* found that maleic acid exerts an attracting influence upon spermatozoids of ferns, while fumaric acid shows no such action.

Again, recent investigations show that maleic acid is more poisonous for the higher animals than fumaric; if per kilo body-weight of a dog are injected 1.94 grams of maleic acid in the form of the sodium salt into the veins it suffices to kill the dog, while with fumaric acid it will not.[3]

It appeared to me of some interest, to investigate, whether analogous physiological differences exist in regard to chlorophyll-bearing plants and the lower aquatic animals.

Preliminary trials showed that highly diluted solutions of the neutral sodium salts of both acids did not exert any noxious influence upon plants; but it may be possible that maleic acid is transformed by the vital activity into fumaric, before it can exert a noxious action. The fact that there is never found in the vegetable kingdom maleic, but fumaric acid is,[4] renders this supposition indeed admissible. Therefore, the neutral sodium salts of maleic and fumaric acids were applied in higher concentrations, and here indeed it became evident that maleic acid acts more noxiously than fumaric acid.

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(1) *E. Buchner.* Ber. D. Chem. Ges. **24,** 1163.
(2) Central-Bl. f. Bact; **12,** 361.
(3) *Fodera*, Chem. Ztg., Dec. 1895.
(4) Fumaric acid was found in *Fumaria officinalis, Corydalis bulbosa, Glaucium luteum*, further in different kinds of *Agaricus* and in *Cetraria islandica.*

I. *Experiments with Leaves.*

Young leaves were placed on the surface of 1 % solutions of the neutral sodium salts of both acids and at the same time in common water for control.

Leaves of	In maleic acid.	In fumaric acid.	In water.
Prunus cerasus	Killed after 4 days.	Killed after 6 days.	Alive.
Brassica campestris	„ „ 3 „	„ „ 5 „	„

II. *Experiments with Whole Plants.*

Barley plants were placed in 2% solutions of the sodium salts ; after 20 hours they were found to be killed by the sodium maleate but were still quite normal in the fumarate, just as in the control case with water.

III. *Experiments with Branches.*

Small young branches 10-15 cm. long bearing leaf-buds, or flower-buds or both, were placed in 1% solutions of the neutral sodium salts and at the same time in common water for control.

Branches of	In maleic acid.	In fumaric acid.	Control.
Oenanthe stolonifera	Killed after 4 days.	Killed after 10 days.	Alive.
Acanthopanax spinosum....	„ „ 7 „	„ „ 9 „	„
Brassica campestris.....	„ „ 3 „	„ „ 7 „	„
Evonymus Thumbergianus	„ „ 5 „	„ „ 7 „	„
Prunus pseudocerasus var. *spontanea* bearing 12 buds.	Killed after 2 days, no bud had opened at all.	After 1 day 10 buds had opened, and on the 3rd day 2 more buds ; on the 4th day however they died.	All buds opened, and remained alive.
Prunus mume bearing 5 flower buds.	No buds opened, after 3 days the ends of the buds turned brown and died.	After 1 day one bud opened, but after 4 days all were killed.	After 2 days all the buds had opened.

IV. *Experiments with Seeds.*

Seeds of barley and radish, six in number were soaked in 2 % solutions of the neutral sodium salts for 2 days, then placed on moistened blotting paper under a bell-jar for germination. After 10 days two barley grains had germinated of those that had been treated with the maleate, three of those with the fumarate and five of the control grains soaked in common water: of the radish seeds all had germinated within 8 days, but the control seeds already within 4 days.

V. *Experiments with Algae.*

Analogous experiments were made with filaments of *Spirogyra* which were placed in 1 % neutral solution of the sodium salts of both acids: the microscopical examination after 4 hours showed that about half the cells had been killed by the sodium maleate, while only very few in the fumarate: after 18 hours all cells in the former solution had been killed, their chlorophyll bodies had lost their normal shape, and the cytoplasm had been much contracted, while in the latter solution about half the cells were still alive; it took here 40 hours to kill them all.

VI. *Experiments with Aquatic Animals.*

The organisms principally observed were infusoria, rotatoria, and copepoda.

All these remained alive in 1 p. m. solutions for several days; but in 5 p. m. solutions they were killed in the sodium maleate after 1 hour 20 min., while in the fumarate after 8 hours: most copepoda and rotatoria died in the former in 45 min., in the latter after 2 hours 3 min. We observe, therefore, in all the cases described here, that *maleic acid shows a more poisonous action than fumaric*, another interesting instance demonstrating the sensibility of the protoplasm towards stereo-isomeric bodies.

On the Physiological Action of Amidosulphonic Acid.

BY

N. Maeno, *Nōgakushi.*

Amidosulphonic acid has been subjected to extended chemical investigations by *Dr. Edward Divers*, Professor in the Imperial University of Japan, and it was he who proposed to test whether this substance would prove just as good a source of nitrogen for plants as the ammonium salts or whether they would be noxious.

Dr. Loew then made some experiments which showed that, while bacteria and mould fungi could utilise the sodium and calcium salts of this acid as soures of nitrogen, and algae are not noxiously affected even by 1 per cent solutions of these two salts, higher plants, on the contrary, are noxiously affected by them. As this fact was so contrary to expectation, a larger series of experiments appeared desirable, to decide whether such an action would generally take place in different groups of phanerogams.

I therefore made experiments not only with entire plants and young branches but also with isolated leaves and with the seeds of various species. It is well known that ammonium salts in a certain concentration act noxiously upon plants as well as upon animals, and that this poisonous nature either decreases or increases in intensity when we substitute one hydrogen atom with other groups; thus, hydroxylamine and diamidogen are more poisonous than ammonia, while on the other hand amido-acetic acid or taurin are not poisonous:

NH_3	Weak poison.
NH_2-NH_2, NH_2-OH	Strong poisons.
NH_2-CH_2-COOH, $NH_2-CH_2-CH_2-SO_2OH$	Not poisonous.

Nencki has found that carbamic acid exerts a poisonous effect upon warm-blooded animals, which is different from the effects of the equivalent amount of ammonia. This proves that hydrolysis into ammonia and carbonic acid is not readily accomplished by

the living cells, and such may also be the case with amido-sulphonic acid taken up by the plants.[1]

NH_2COOH — Carbamic acid.

NH_2SO_2OH — Amido-sulphonic acid.

In all my experiments with whole plants, young branches and isolated leaves, I used a 1 p. m. or 0.5 p. m. amido-sulphonic acid solution in the form of the calcium salt.[2] To these solutions were further added 0.05 % mono-potassium phosphate, 0.05 % magnesium sulphate and 0.2 % calcium sulphate. The control-solution contained in place of amidosulphonate, an equal amount of ammonium sulphate.

At the same time one or more of the plants were also placed in distilled water.

We will call for the sake of abbreviation the plants in the solution containing the amidosulphonate (A) ; those in ammonium sulphate (B), and the plants in distilled water (C).

I. *Experiments with Whole Plants.*

Barley plants were taken carefully from the field on the 19th February and after carefully washing the roots, they were placed in the solutions mentioned. The result is seen from the following table :

	Length of plants at the beginning.	Length of plants after 9 days.	Water absorbed in 6 days.
A	24.5 cm.	24.5 cm.	46 c. c.
B	24.0 „	25.0 „	105 „
C	21.0 „	23.0 „	120 „

The plant (A) appeared so much damaged by the withering of the leaves on the 9th day that complete death set in two days later ; the chlorophyl of the younger leaves had turned yellow before they succumbed. While no traces of new rootlets were to be observed in the plant (A), the control plants which remained healthy for a long time had developed them in great numbers.

(1) According to an observation of *Dr. Divers* to whom thanks are due for having provided our laboratory with a large amount of amidosulphonic acid, only the ammonium salt of this acid is easily hydrolysed in aqueous solution.

(2) In a few cases I also used the sodium salt with the same results.

For the next experiment young plants of *Brassica Rapa* 14 cm. in height were selected. Although the amount of amidosulphonic acid here did not exceed 0.5 p. m. the plants (A) died within 7 days, while the control plants B and C remained healthy.(1)

In the third experiment plants of *Allium fistulosum* about 30 cm. in length were placed in 0.5 p. m. solutions.

A noxious effect was here noticed after 14 days, the tips of the leaves became yellow, lost their turgor, and withered. Complete death had set in after 29 days with the plants A, while the control plants B and C still exhibited a healthy appearance.

The plants A had grown during the first 7 days 9 cm. on the average, but the plants B more than double that height.

For the fourth experiment young plants of Soya beans were used. The seeds were soaked for several days in water and then left to germinate on moistened filter paper. The shoots were placed in 1 p. m. solutions. In this case not only the amidosulphonate but also the ammonium sulphate exhibited a decidedly noxious action.

	Length of the shoots.		Death set in :
	At the beginning :	After 11 days :	
A	8 cm.	8 cm.	In 11 days.
B	9 „	9 „	In 14 „
C	8 „	18 „	—

II. *Experiments with Branches.*

In the 1 p. m. solutions above mentioned were placed on the 3rd of March, small twigs of *Prunus domesticus* 12-15 cm. length and bearing flower-buds; the buds of those twigs that were kept in water opened on the next day. One day later, the buds of the branches kept in ammonium sulphate followed and 4 days later, those of the branches in amidosulphonate (A). On

(1) Diamidogen in a dilution of 0.5 p. m. killed the plants in about the same time as amidosulphonic acid.

the 10th of March, however, the 4 blossoms (A) had dried up while the still closed buds died in this state. The branches in water, however, had 14 and those in ammonium sulphate 11 healthy blossoms. In other experiments, the solutions were applied in half the concentration as before but the result was essentially similar ; after 8 days, all the 14 buds on the branches (A) had withered and become brown, while the branches (B) and (C) with all their opened buds remained healthy.

III. *Experiments with Leaves.*

Young leaves of *Aesculus turbinata* 15-17 cm. in length were placed in 1 p. m. solutions.

After 4 days, a loss of turgor could be observed with the plants A, and several days later black spots appeared, especially along the veins, which spread gradually and extended over all the leaves after 11 days. The leaves B and C, however, retained their normal appearance. This experiment was repeated with solutions of half the concentration with essentially the same results. In the next experiment, leaves of *Prunus cerasus* (5 pieces) were placed in 0.5 % solutions. After 5 days, brown spots developed on the leaves A, which after 8 days had spread so much that the leaves might be considered as completely killed. Soon afterwards, the solution in which these leaves were kept became reddish from extracted organic matters.

The leaves B showed at this time only very small and few brown spots, while leaves C showed only one such spot of very small size.

IV. *Experiments with Seeds.*

Seeds of rice, barley, soya bean, and turnips, 20 of each, were placed for 58 hours in 0.5 % solution of calcium amidosulphonate (A) ; in ammonium sulphate (0.5 %) (B) and again in pure water (C).

The seeds were then placed on moist filter paper, covered with a bell jar, and the number of germinated seeds counted every evening for twelve days. The result is given in the following table :

		1	2	3	4	5	6	7	8	9	10	11	12
Rice	A	0	0	0	0	0	0	0	1	7	7	7	7
	B	0	0	0	0	0	7	7	7	20	20	20	20
	C	0	0	0	0	0	7	9	10	17	19	19	19
Barley	A	0	4	7	9	11	11	12	12	12	13	13	13
	B	0	4	9	11	11	12	13	13	15	16	16	16
	C	0	9	11	12	15	16	17	18	19	19	19	19
Soya bean	A	0	0	0	0	0	0	0	0	0	0	0	0
	B	0	0	0	2	7	8	10	13	17	17	17	17
	C	4	4	7	11	16	16	16	17	17	18	18	18
Turnips	A	0	0	0	0	0	0	0	0	1	2	2	2
	B	0	2	7	15	17	17	18	19	19	19	19	19
	C	0	6	15	18	18	18	18	18	18	18	18	18

These results demonstrate again the noxious effects of the amidosulphonic acid, but how the differences in poisonous intensity are to be accounted for, I am unable to say. Perhaps the calcium salt of that acid penetrates more easily into the embryo of one kind than into those of the other. Thus it might also be explained why seeds of buckwheat and sunflowers were not damaged at all by the same treatment as killed all the soya germs completely (see table).

V. *Experiments with Yeast.*

It appeared to me of some interest to see whether the amidosulphonic acid would also show a noxious influence upon yeast.

For this purpose, I distributed 10 cc. of thick beer yeast in distilled water and diluted the mixture to 100 cc. After well shaking, I took 10 cc. of the mixture immediately after shaking and added 90 cc. of a glucose solution containing 6.856 grams pure glucose, 0.1 gram magnesium sulphate, 0.2 gram dihydropotassium phosphate, and 0.1 gram. sodium amidosulphonate, A.

In the control case instead of the last, ammonium sulphate was used, B.

10 cc. of the diluted yeast applied corresponded to 0.0613 gram dry matter.

After 5 days' fermentation, the mixtures were filtered off and on the one hand, the dry matter of the yeast, on the other, the amount of sugar still present were determined.

The yeast A weighted 0.165 gram, the yeast B 0.198 gram. The volumetrical sugar determination still showed in the flask A 3.52 gram, in B, however, only 3.07 gram, of sugar.

	A	B
Increase of yeast in grams	0.1037	0.1367
Increase of yeast in percentages of dry yeast.	169 %.	223 %.
Sugar fermented in grams	3.3360	3.7860
Sugar fermented in percentages of dry sugar.	48.80 %.	55.20 %.

We see, therefore, that the amidosulphonic acid does not prevent the growth and fermentative power of the yeast, but it is a less favourable source of nitrogen than ammonium sulphate, which again is a surprising fact, as the chemically powerful yeast-cells should in our opinion be capable of easily bringing on the hydrolysis of the amidosulphonic acid.

VI. *Experiments with Mammalia.*

I made in this regard but few experiments. Into a white mouse was injected subcutaneously 0.5 cc. of a 1 % solution of sodium amidosulphonate. Since I could not observe any noxious effects after 48 hours, I injected once more 1 cc. of the same solution. Soon afterwards a considerable increase of the respiratory activity was noticed, but 2 days later the mouse was in a normal state again.(1)

In another experiment, I soaked bread in a 1 % solution of sodium amidosulphonate and fed a mouse with it. This animal became gradually very weak and somnolent, and died after 76 hours. In this case perhaps such a large quantity of the

(1) This result agrees with those obtained by Prof. *Takahashi* in the Imperial University in Tokyo. The observations of Prof. *O. Loew* on lower aquatic animals, which remained alive in 1 p. m. solution of calcium amidosulphonate, are also in accordance with my results.

amidosulphonate was introduced into the body that no safe conclusion as to its poisonous character can be inferred. *Nencki* had observed that 0.6 gram of sodium carbamate per kilo of body weight upon injection into the blood of a dog produces tetanical convulsions and sometimes death, 0.3 gram per kilo will produce somnolence[1] and catalepsy. As in the above first mentioned case the relative amount of amidosulphonate was nearly the same, it becomes evident that amidosulphonic acid is not so noxious to animals as the related carbamic acid.

To summarise:

Amidosulphonic acid occupies an exceptional position among the poisons: it is neither poisonous to higher or lower animals, nor to fungi and algae, but it is poisonous to all kinds of phænogams. Although no poison for fungi it is not so favourable a source of nitrogen for them as ammonium salts.

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(1) Carbamic acid continuously produced in the body, is rapidly transformed into urea, nevertheless it may possibly exert some influence upon the causation of the normal sleep. Cf. on this point also the interesting publication of *Leo Errera*, Sur le Mecanisme du Sommeil, *Bruxelles*, 1895.

Investigations on the Mulberry Tree.

BY

N. Maeno, *Nōgakushi.*

I. *Improvements in the Quality of Mulberry Leaves by a Special Manure.*

It is a fact that in certain provinces of Japan a better silk is produced than in others, although the silk worm is sometimes of the same variety. It may be surmised that the nature of the soil exerts much influence on the quality of the leaves used as food by the caterpillar. The relative amount of digestible and indigestible material in mulberry leaves must naturally have a certain bearing upon the well-being of the silkworms and hence also upon the quality of the thread produced. This led me to institute some experiments with the intention of attaining a decrease in the amount of woody fibre and especially an increase in the amount of proteid and fat. I supposed that manuring with lime, calcium sulphate, and sodium nitrate would be especially well adapted for the production of such a superior quality of leaves, and thought it best to apply lime in the form of slaked lime, hoping thereby also to destroy the mycelium of a very noxious fungus,[1] found in our mulberry plantation at the College of Agriculture in Tokyo.

The soil consists here principally of volcanic ash mixed with sand, and contains from 7-8 % humus. It is rather poor in lime and sulphates and had received, one year before I commenced my experiment, a moderate dose of night soil as manure for the trees. I manured a mulberry tree about $1\frac{1}{2}$ meter high with 500 grams lime, 400 grms. sodium nitrate and 200 grms. calcium sulphate[2] in the beginning of March (A), while another tree was manured with 500 grms. lime alone (B); a neighbouring tree received no manure and served for comparison (C).

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(1) *Helicobasidium Mompa*, studied by *Tanaka*, Journal of the College of Science, Tokyo, Vol. IX.

(2) These materials were well mixed with the soil to a depth of about 30 cm. and to an extent of one square meter around the tree. I wanted to have phosphoric acid, potassa, and magnesia in the minimum, and supposed there was some left in the soil from the year before.

On the 20th May, a number of leaves were collected from each tree for analysis ; each leaf measured on the average 9 cm. in length and weighed on the average (of 50) in case (A) 0.320 gram ; in (B) 0.304, in (C) 0.303 gram. On analysis, I obtained the following results.

	A	B	C
Water	80.82	80.85	80.04
Dry matter	19.18	19.15	19.96
Organic matter (in the dry substance)	91.63	90.98	91.19
Ash	8.37	9.02	18.81
Fibre	13.10	13.68	18.11
Fat	5.34	4.56	4.49
Total carbohydrate	23.14	22.92	23.44
Crude protein	28.56	23.31	23.25
Total nitrogen	4.25	3.73	3.72
Albuminoid nitrogen	3.47	3.29	3.28
Amido-nitrogen	0.78	0.44	0.44
Non-nitrogenous extract (except carbohydrate)	21.49	26.51	21.90

We observe here that by liming alone, the percentage of woody fibre decreased from 18.10 % to 13.68, while the non-introgenous extract had increased from 21.90 to 26.50 % ; further by liming and manuring with sodium nitrate and calcium sulphate, not only had the amount of fibre deceased from 18.11 to 13.10 % but the proteid had increased from 23.25 to 28.56 % and the fat from 4 49 to 5.34 %.

It can not be denied that this special manuring produced leaves of superior nourishing quality and it remains to compare the effect of these different leaves upon the silk worm.[1]

II. *On the Amount of Reserve Material in the Bark of the Roots and Branches of the Mulberry Tree.*

It appeared to me of some interest to determine the extent to which the reserve material deposited in root and branches is consumed in spring time.

On the 25th January roots about 1 cm. in diameter were collected whose *bark* was separated for analysis (α). This was re-

(1) In September of the same year the tree B had gained in height one fourth and the tree A about one third compared with the control tree C.

peated with roots of the same tree and nearly of the same diameter on the 27th April (β), when the leaves were developed. The analysis shows that a *decrease* of proteids and non-nitrogenous extract had taken place on the one hand, while on the other hand an *increase* of starch ; fat and fibre had remained nearly constant while lecithin disappeared almost completely.[1] In connection with the decrease of proteids, an increase of amido-nitrogen and especially of asparagine nitrogen is of interest.

Also the *bark* of the *branches* was subjected to analysis at two different periods.

The sample (α) was collected on the first of March before the leaf buds opened and the sample (β) after the development of the leaves on the 27th April.

Here we observe not only a decrease of proteids (with increase of asparagine) but also a decrease of fat, lecithin, and total carbohydrate.

The result is seen from the following table :

	Root.		Branch.	
	(α)	(β)	(α)	(β)
Water	67.01%	70.38%	53.2%	73.88%
Dry matter	32.99	29 62	46.80	26.12
Organic matter	96.43	96.78	94.10	94.02
Ash	3.57	3.22	5.90	5.98
Fibre	31.130	32.420	35.770	46.500
Fat	6.700	6.300	7.290	6.700
Lecithin	0.999	trace	1.076	trace
Total carbohydrate	15.040	26.500	19.800	17.200
Sugars and dextrin	6.600	10.500	13.300	9.070
Starch	8.440	16.000	6.500	8.130
Crude protein	9.450	7.187	10.312	9.956
Total nitrogen	1.512	1.150	1.650	1.593
Albuminoid nitrogen	0.898	0.394	1.294	1.040
Amido-nitrogen	0.094	0.100	0.005	0.003
Asparagine nitrogen	0.520	0.656	0.351	0.550
Non-nitrogenous extract (except carbohydrate)	33.111	27.592	26.827	19.644

(1) I may here draw attention to the recent observations of *Stoklasa* upon the formation of lecithin in the leaves in daylight and its disappearance in darkness.

Analytical Data.

1. Determination of fibre.

	Dry matter in grms.	Fibre in grms.	Percentages.
Root (α)	2.7270	0.8490	31.13
,, (β)	2.8536	0.9250	32.42
Bark (α)	2.7870	0.0940	35.77
,, (β)	2.7066	1.2605	46.50
Leaf (A)	1.8505	0.2425	13.10
,, (B)	1.8385	0.2515	13.68
,, (C)	1.8270	0.3210	18.11

2. Determination of fat.

	Dry matter in grms.	Fat in grms.	Percentages.
Root (α)	3.6360	0.2440	6.70
,, (β)	3.8048	0.2440	6.30
Bark (α)	3.7160	0.2710	7.29
,, (β)	3.6088	0.2420	6.70
Leaf (A)	1.8505	0.1085	5.34
,, (B)	1.8385	0.0840	4.56
,, (C)	1.8270	0.0820	4.49

3. Determination of lecithin by *E. Schulze's* method.

	Dry matter in grms.	Lecithin in grms.	Percentages.
Root (α)	3.6360	0.03635	0.999
,, (β)	3.8048	trace	
Bark (α)	3.7160	0.03998	1.076
,, (β)	3.6088	trace	

4. Determination of total carbohydrate.

	Dry matter in grms.	Total carbohydrate in grms.	Percentages.
Root (α)	1.3635	0.2050	15.04
,, (β)	1.9025	0.5048	26.50
Bark (α)	1.8580	0.3678	19.80
,, (β)	1.8044	0.3152	17.20
Leaf (A)	1.3878	0.3212	23.14
,, (B)	2.7576	0.6320	22.92
,, (C)	2.7405	0.6424	23.44

5. Determination of sugars.

	Dry matter in grms.	Sugar in grms.	Percentages.
Root (α)	4.5450	0.3004	6.60
,, (β)	1.9025	0.2010	10.50
Bark (α)	1.8580	0.2490	13.30
,, (β)	1.8045	0.1640	9.07

All sugar determinations were made by *Allihn's* method.

6. Determination of total nitrogen.

	Dry matter in grms.	Baryta-water in cc.	Percentages.
Root (α)	1.8180	12.8	1.512
,, (β)	0.9512	3.5	1.150
Bark (α)	0.9290	7.2	1.650
,, (β)	0.9022	4.6	1.563
Leaf (A)	0.9252	12.6	4.250
,, (B)	0.9192	11.0	3.730
,, (C)	0.9135	10.9	3.720

7. Determination of proteid nitrogen by *Stutzer's* method.

	Dry matter in grms.	Baryta water in cc.	Percentages.
Root (α)	0.9090	3.8	0.898
,, (β)	0.9512	1.2	0.394
Bark (α)	0.9290	5.6	1.294
,, (β)	0.9022	3.0	1.040
Leaf (A)	0.9252	18.2	3.470
,, (B)	0.9192	9.7	3.290
,. (C)	0.9135	9.6	3.280

8. Determination of asparagine nitrogen by *Sachsse's* method.

	Dry matter in grms.	Baryta water in cc.	Percentages of nitrogen × 2.
Root (α)	4.5450	5.5	0.520
,, (β)	2.8536	3.0	0.656
Bark (α)	4.6450	3.8	0.351
,, (β)	2.7066	2.4	0.550

In the case of root (α) and bark (α) 1 cc. baryta water =2.14806 mgm. nitrogen and in the case of root (β), bark (β), leaf A, Leaf B, and leaf C, 1 cc. baryta-water=3.12445 mgm. nitrogen but only in the case of leaf A in proteid nitrogen determination 1 cc. of baryta-water=1.77115 mgm. nitrogen.

Notes on the Metabolism in the Cherry Tree.

BY

S. Aoyama, *Nōgakushi.*

Numerous investigations of *Sachs*, *Nobbe* and others have shown that the bark and wood of trees store up during the autumn a considerable amount of reserve-material which is transported there from the leaves and partially prepared in the living bark itself. This material not only serves for the nutrition of the cambium but also is partially transported to the buds of the leaves and flowers during their development in spring. *Robert Hartig* has found that in the wood of the trunk of the red beech and oak, starch is deposited to a considerable extent. With old trees of red beech the fifty exterior annual rings contain reserve-starch which is used up in those years in which seeds are produced. In other years, however, only the last two rings show in summer a decrease in starch, while in October starch is again deposited in them.

This author therefore infers that for the nutrition of the leaf-buds in spring the reserve-material from the *branches* is mainly used. *Rudolph Weber* has especially examined the rate of decrease in proteid and mineral matter in the old and young parts of the trunk of the beech tree during a year of seed production, and has found that a large amount of nitrogenous matter and magnesium salts migrate from the wood to the growing seeds.[1]

Russow and *A. Fischer* found that conifers store up the reserve-material free from nitrogen principally in the form of fat, while many other trees, especially hard wood trees, store it up in the form of starch. The amount of reserve-material, further, will probably vary under different conditions, especially in different climates.

It is an interesting fact that in the central and southern parts of Japan the cherry trees generally bear no fruit[2] and in certain cases in which the development of fruit takes place the fleshy part remains imperfectly developed. On the other hand these trees show in spring a most luxuriant development of flowers,

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(1) *Dr. v. Tubeufs* Forstlich-naturwissenschaftliche Zeischrift, vol. I. (1892).

(2) Only one variety forms an exception.

which form a dense cover of the branches before the leaves appear.

It is evidently the peculiar climatic condition of central and southern Japan which prevents the production of normal cherries and causes the fruit to fall off in an unripe condition. This circumstance must naturally lead to the accumulation of a great amount of reserve-material in the bark and wood, that would otherwise have been consumed by the ripening fruit, and this is clearly also the cause that leads to the development of such an extraordinary and astonishing abundance of blossoms in the following spring. I therefore believed it of some interest to determine the amount of reserve-material in winter and to compare it with the extent of the consumption of this reserve-material in spring when flowers and leaves have been formed.

Branches 1—1.5 cm. in thickness were collected on the 20th January (A) and, again of the same tree, branches of the same size on the 13th April (B) on which day also I collected from the same tree young leaves and flowers.

Only the leaving part of the bark, containing more or less cambium, served for analysis.[1] The results I obtained are the following :—

	Bark (A)	Bark (B)	Leaf.	Flower.
Total water	52.64	53.41		
	In 100 parts of dry matter.			
Crude protein	9.50	6.69	34.94	20.13
Crude fat	6.84	5.34	8.99	10.04
Crude fibre	34.79	38.98	14.49	20.06
Carbohydrate	27.13	18.06	11.82	12.50
Crude ash	7.76	7.93	6.51	7.25
Non-nitrogenous extract	12.46	21.93	17.66	26.80
Total nitrogen	1.52	1.07	5.59	3.22
Albuminoid nitrogen	1.18	0.84	4.55	2.40

If we compare the precentage composition of bark (A) with that of bark (B), we can obtain no clear distinction between relative and absolute numbers, *i.e.* between the apparent and real decrease or increase of the different constituents ; evidently a

(1) The *wood* was not examined. Some trees contain more starch in March and April than in January (*Rosenberg*, Bot. Centrbl. **66**, 337). Cf. also the above examination of the root of the mulberry tree, by Maeno. It may be that in such cases fat and proteins contributed to the formation of starch.

more correct estimation as to the changes can be obtained if we take the fibre as a constant quantity, which may here safely be done, and recalculate the numbers for proteids, fat, and carbohydrate. We obtain now the following results :—

	(A)	(B)
Fibre	100.00	100.00
Crude Proteid	27.31	17.16
,, Fat	19.67	13.70
Carbohydrate	77.98	46.33
Hence the proteids decreased		37.16 %
Fat decreased		30.35 ,,
Carbohydrate decreased		40.59 ,,

This shows that the bark of the twigs plays a very important part as a reservoir for the development of the buds in spring.

Analytical Data.

Determination of total nitrogen.[1]

	Dry matter, g.	Baryta-water, cc.	Percentage of nitrogen.
Bark (A)	0.946	6.70	1.52
,, (B)	0.890	5.30	1.07
Leaf	0.883	27.90	5.59
Flower	0.879	16.00	3.22

Determination of albumoid nitrogen by *Stutzer's* method.

	Dry matter, g.	Baryta-water, cc.	Percentage of nitrogen.
Bark (A)	0.946	5.40	1.18
,, (B)	0.890	4.20	0.84
Leaf	0.883	22.70	4.55
Flower	0.879	11.90	2.40

Determination of crude fat.

	Dry matter, g.	Crude fat.	Percentage.
Bark (A)	4.728	0.3235	6.84
,, (B)	4.449	0.2377	5.34
Leaf	4.415	0.3970	8.99
Flower	4.396	0.4415	10 04

(1) All the nitrogen determinations were made by *Kjeldahl's* method.

10 cc. of sulphuric acid were put in the receiver.

In the case of bark (A), 1 cc. sulphuric acid = 3.16 baryta-water solution, and 1 cc. baryta-water = 2.14806 mgr. nitrogen.

In the case of bark (B), 1 cc. sulphuric acid = 2.16 baryta-water solution, and 1 cc. baryta-water = 1.77115 mgr. nitrogen.

Determination of crude fibre.

	Dry matter, g.	Crude fibre.	Percentage.
Bark (A)	4.728	1.644	34.79
,, (B)	2.670	1.041	38.98
Leaf	2.649	0.381	14.49
Flower.	2.637	0.529	20.06

Determination of carbohydrate.[2].

	Dry matter, g.	Total carbohydrate, g.	Percentage.
Bark (A).....	4.728	1.283	27.13
,, (B)	2.670	0.482	18.06
Leaf	2.649	0.313	11.82
Flower	2.637	0.330	12.50

(1) This determination was made by the acid-alkali method.

(2) This carbobydrate consists of starch and sugar; the determination was made by *Allihn's* method.

Physiological Observations on Lecithin.

BY

T. Hanai, *Nōgakushi.*

It is a well known fact that lecithin occurs widely distributed in the vegetable and animal kingdoms, forming in various proportions an admixture with fatty matters. Only a limited number of observations have however been made in regard to the physiological relations. It was found by *Maxwell*,[1] that the amount of lecithin increases during the germination process of plants, and later decreases again. *S. Frankfurt*[2] observed that during the germination of *Helianthus* seeds the amount of lecithin increased from 0.44 to 0.85 % while the amount of fat decreased from 55.32 to 24.54 %. It seems very probable that in reality much more lecithin had been formed during the germination process than was actually found, and that a part of it again was consumed.[3]

O. Loew made some experiments with a diluted solution of lecithin in regard to the capability of nourishing lower fungi, and observed that *Penicillium* could not, in the absence of other organic material, develop in a 0.1 % solution of lecithin containing the necessary mineral nutrients, but only bacteria to a moderate extent; this vegetation made the impression of a pure culture, although the infection was made from putrid meat containing various kinds of microbes.[4]

Seeds rich in starch generally contain much less lecithin than such as are rich in proteid, thus barley grains contain less than half the amount of lecithin that soja-beans do.[5]

Probably there is also a larger proportion of lecith-albumin[6] in the seed of soja and lupin than in those of squash and barley.

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(1) Chem. Central-Blatt., **91**, I. 365.

Hefter observed a decrease of the amount of lecithin in the liver during starvation.

(2) Landw. Vers.-Stat., Vol. XLIII, 143.

(3) Recently *Stoklasa* (Wien. Akad. Ber., 1895) has found that lecithin forms a suitable source of phosphoric acid when offered to the roots; he also observed its formation in green leaves as well as its consumption in darkness.

(4) Bull. Coll. of Agr. of the Imp. Univ. of Japan; Vol. II. No. 2.

(5) *Schulze* and *Steiger*, Zeitschr. physiol. Chem., **13**, 386.

(6) Cf. *Leo. Liebermann*, *Pflüg.* Arch., 1893.

E. Schulze found further that during the germination of seeds the quantity of *cholin* increases,[1] and that in wheat cholin and betain which are closely related to each other, are localised in the *germ* of the grain but not in the endosperm. This is certainly of physiological interest because the young developing germ must carry on an energetie respiration and therefore be capable of easily forming lecithin, in which process the presence of cholin is required. It may further be mentioned in this connection that, according to *Müntz*, the amount of free fatty acids increases during germination.

For my investigation I selected the leaves of *Thea chinensis*, an *evergreen* plant, and the bark of *Prunus Cerasus*, which objects contain during winter time much reserve material ; especially the tea leaf is rich in fatty matter. *Kellner*, *Makino*, and *Ogasawara*[2] observed that while in May and June young tea leaves contain 6.32-6.82 % of fat, in November they contain as much as 22 % in the dry matter. I determined the lecithin after the method of *E. Schulze* by which after the extraction with ether, a second extraction is made with absolute alcohol.[3] In these united liquids the phosphoric acid is determined in the usual way, after heating the evaporation-residue with a mixture of sodium carbonate and some potassium nitrate.

I made four determinations, one with the *old* leaves in November (1895), the second with the *old* leaves in May 1896, the third with the *young* leaves at the beginning of April 1896 and the fourth with the *young* leaves at the end of May (1896), with the following result :

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(1) Landw. Vers.-Stat.. Vol. **46**, 23.

(2) Landw. Vers.-Stat. 1886. p, 370.

(3) The mixture of these two extracts contains, of course, besides fat and lecithin a certain amount of other compounds.

No.	Dates of collection.	Water in the fresh leaves, per cent.	In 100 parts of the dry matter.	
			Ethereal and alcoholic extract.	Lecithin.
1.	Old leaf 20 November (1895)	67.57	26.18	2.54
2.	Old leaf 26 May (1896)	61.88	18.19	0
3.	Young leaf 1 April (1896)	77.66	9.44	0.21
4.	Young leaf 26 May (1896)	70.90	18.67	1.11

This result shows that the old tea leaves lose the reserve-lecithin in spring, while the amount of it increases gradually in the young leaves. The decrease and the increase of lecithin here goes parallel with that of fat although not in a fixed proportion.

The bark of *Prunus Cerasus* was collected on the 23rd October 1895, when the leaves had mostly fallen from the tree, while the second collection was made on the 5th April 1896 when numerous flower-buds were formed, and the third time on the 9th April 1896, when the flower-buds had *opened*.

In the three cases the bark was taken from the same tree whereby special attention was paid, that branches of equal thickness were selected ; the results were as follows :

No.	Dates of collection.	In 100 parts of the dry matter.	
		Ethereal and alcoholic extract.	Lecithin.
1.	23 October (1895)	10.53	1.88
2.	5 April (1896)	10.97	0.96
3.	9 April (1896)	9.52	0.71

It is also here quite evident that lecithin is a reserve material which is consumed in spring.

Analytical Data.

For the determination of the lecithin always 10 grm. of dry matter were taken; the amount of magnesium pyrophosphate found was as follows :

	Ethereal and alcoholic extract.	Magnesium pyrophosphate.	Lecithin.
Old leaf of Thea chinensis. 20. Nov. (1895).	2.618	0.035	0 254
Old tea leaf. 26 May (1896)	1.819	—	—
Young tea leaf. 1 April (1896)	0.944	0.003	0.021
Young tea leaf. 26 May (1896)	1.867	0.015	0.111
Bark of *Prunus Cerasus*. 23 Oct. (1895) ...	1.053	0.025	0.188
Bark of *Prunus Cerasus*. 5 Apr. (1896) ...	1.097	0.013	0.096
Bark of *Prunus Cerasus*. 9 Apr. (1896) ...	0 952	0.009	0.071

On a Compound of Albumin with Phenol.

BY

M. Shimada, *Nōgakushi.*

Finely powdered dry egg-albumin dissolves gradually when heated with 10 times of its weight of phenol for several hours on the water bath. From this solution alcohol precipitates a flocculent mass, which, after washing with alcohol and water, represents a compound of albumin and phenol.[1]

This compound is without taste or smell, insoluble in boiling alcohol and water, and in solution of potassium carbonate, easily soluble in hot phenol. In concentrated acetic acid it swells up gradually, while potassium hydroxide, even in dilution of 0.5 per cent, dissolves it; from this solution acetic acid precipitates it again.

It is not attacked in the cold by hydrochloric acid of 10 per-cent, but gradually dissolved by one of 35 per cent. Nitric acid of 5 per cent has no effect on it at the ordinary temperature, but on boiling with concentrated nitric acid, a yellow colouration is obtained. It gives the biuret and *Millon's* reaction like common albumin.

1 grm. of this product was digested with 20 cc. of concentrated hydrochloric acid at 100° C. for several hours, and then the liquid was subjected to distillation in order to see, whether phenol was hereby liberated, but the distillate obtained did not give a trace of turbidity with bromine water. The same negative result in regard phenol was observed in the following experiment, which was made to see whether that new compound would also yield leucine and tyrosine, like the common albumin.

I heated 3 grm. with 15 cc. of sulphuric acid of 30 per cent for seven hours on the water bath and then for a short time on the sand bath.

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(1) If the amount of alcohol is too small, then instead of a flocculent mass, a tenaceous mass is separated, from which the adhering phenol can be removed only by prolonged washing. (2) Peptone behaves similarly to albumin. O. L.

(2) This did not show the biuret reaction but yielded a very copious precipitate with phospho-tungstic acid, pointing to a considerable amount of basic compounds.

Upon dilution with water, boiling with barium carbonate, evaporation of the filtrate and extraction with alcohol containing some ammonia, a characteristic crystallisation of leucine and tyrosine was obtained. The leucine was also recognised by the odour of amylamine on heating, while it showed tyrosine by *Millon's* reaction.

Whether also arginine, lysine, aspartic acid, glutamic acid and phenyl-amido-propionic acid was formed, I hope to decide later with larger quantities.

For analysis the product was dried at 100° C.

I. 0.230 grm. gave 0.4863 grm. CO_2 and 0.149 grm. H_2O.
$= 57.65\ \%$ C and $7.2\ \%$ H.

II. 0.1636 grm. gave 0.3500 grm. CO_2 and 0.103 grm. H_2O.
$= 58.34\ \%$ C and $7.0\ \%$ H.

I. 0.5000 grm. gave after *Kjeldahl's* method
68.03 mg. $N = 13.60\ \%$ N.

II. 0.5000 grm. gave 67.22 mg. $N = 13.45\ \%$ N.[2]

I. 1.0000 grm. substance gave after heating with a mixture of sodium carbonate and some potassium chlorate 0.117 grm. $BaSO_4 = 1.60\ \%$ S.

II. 1.0000 grm. yielded by the same method 0.090 grm. $BaSO_4 = 1.30\ \%$ S.

These results would correspond approximately to an albumin in which three hydrogen atoms have been replaced by three phenyl groups, when *Lieberkühn's* formula is taken as a foundation.

The product must then have been formed according to the following equation :—

$$C_{72}H_{112}N_{18}SO_{22} + 3(C_6H_5OH) = C_{72}H_{109}(C_6H_5)_3N_{18}SO_{22} + 3H_2O.$$

	Theory.	Experiment.	
		I.	II.
C	58.69	57.65	58.34
H	6.74	7.20	7.00
N	13.70	13.60	13.45
S	1.74	1.60	1.30
O	19.13		
	100.00		

(1) Another sample yielded *Suzuki*, of this College, 14.44 % nitrogen.

I prepared the compound several times and always observed essentially the same properties.

As it appeared to me of some interest to test whether this product would show, in the absence of air, antiseptic properties on account of the introduction of phenyl groups, I dissolved 1 grm. in potassium hydroxide solution of 1 per cent and added dilute acetic acid until a precipitate commenced to be formed, diluted to 100 cc., and infected the solution from putrified meat. The filled flask was provided with a stopper, carrying a U-tube containing some mercury to exclude the air.

After seven weeks standing at the ordinary temperature, the liquid appeared turbid and contained a flocculent sediment.

Upon opening a putrid smell was noticed and the microscope revealed a rich bacterial vegetation.

Triphenylalbumin is therefore a good nutrient for microbes and is subject to fermentation like the ordinary albumin.

明治三十年一月卅一日
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